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The fishery for cockles *(Cardium edule* L.) in the Burry Inlet, South Wales

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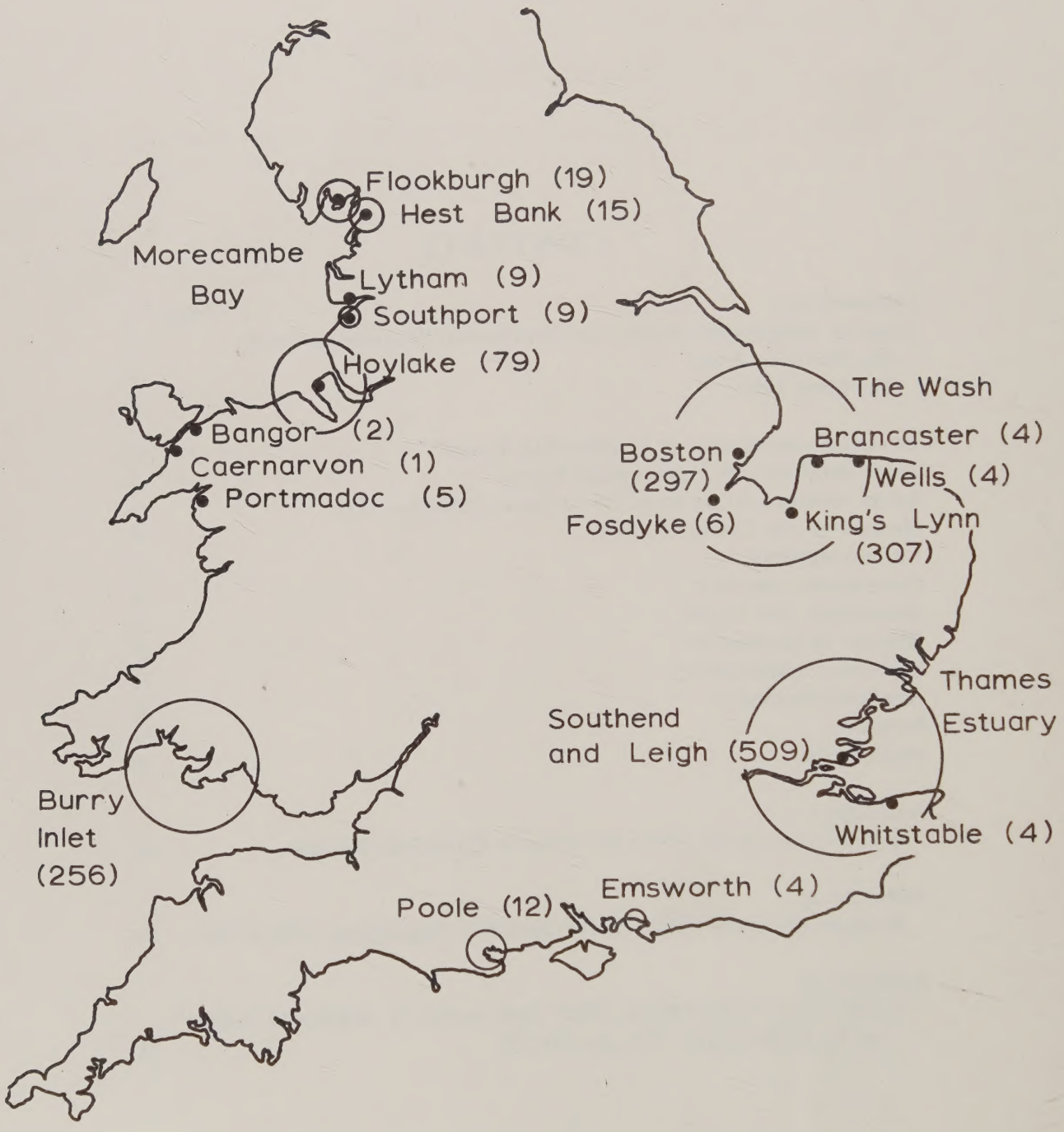


Fig. 1. *Average annual landings of cockles (in 100 cwt units) in England and Wales for the five years 1958-1962, based on figures from M.A.F.F. Sea Fisheries Statistical Tables. Only ports where more than 100 cwt are landed annually are shown.*

The Fishery for Cockles *(Cardium edule* L.) in the Burry Inlet, South Wales

INTRODUCTION

LLANRHIDIAN SANDS, in the Burry Inlet, South Wales, has been the site of a cockle fishery for many years and annual landings from this relatively small area are exceeded only by those from the vast areas covered by the cockle fisheries of The Wash and the Thames Estuary (Figure 1). In 1953 and 1954 the quantity of cockles landed in all three areas was very similar, those from the Burry Inlet constituting one third of the country's recorded total.

Since then however the landings from Llanrhidian Sands have shown a steady decline until by the early 1960s the quantities gathered by each fisherman had reached subsistence level, gatherers were leaving the fishery to take shore occupations, and the annual landings were the lowest since records were commenced in 1924.

Not only is this area the source of a valuable natural food, but it has always provided employment for a substantial number of people, mainly women, engaged not only on gathering the cockles, but also on cooking them and retailing them at the door and on the markets. Cockles are a popular delicacy in South Wales, and the old traditions associated with their collection provide an unfailing source of interest to the local public.

In 1957 the South Wales Sea Fisheries Committee, the body responsible for the administration of inshore fisheries in the area, appealed to the Ministry of Agriculture and Fisheries to make a scientific investigation into the causes of the declining landings, with a view to framing more effective regulations leading to the better exploitation of the stocks and maintenance of the beds.

The purpose of this paper is to describe the Llanrhidian Sands cockle fishery and the events leading to the recent shortage of cockles, followed (in subsequent publications) by a full account of the research programme which was commenced in 1958, its conclusions and recommendations.

GENERAL TOPOGRAPHY OF THE CARMARTHENSHIRE/GLAMORGAN COAST

THE Burry Inlet forms part of Carmarthen Bay (Figure 2) which, together with Swansea Bay, originated as drowned parts of several rivers, now almost filled up, partly with glacial material (Steers, 1948). The only areas sheltered to some extent from the prevailing south-westerly winds are Swansea Bay, the Burry Inlet and the estuaries of the Taf, Towy (Tywi) and Gwendraeth ("the Three Rivers") together with some of the small bays of the Pembrokeshire and South Gower coast. Of these only the Burry Inlet and the estuaries of the three rivers do not receive the full force of storm-driven seas, and it is in these protected areas that cockles regularly settle, survive and grow to commercial densities.

The western side of Carmarthen Bay, though sheltered from the prevailing winds, is scoured by the sweep of the current and although cockles settle occasionally in the vicinity of Tenby and Saundersfoot there are never enough to support a regular fishery. Wright (1927) however reported a thriving bed of rapidly growing cockles at Saundersfoot, covering the shore from the cliffs down to low-water mark. The extensive sand flats from Pendine to Pembrey are mainly inaccessible because of military installations, but this area is probably too exposed to have useful beds of cockles.

The small bays of the Gower Peninsula are known to have contained small beds of cockles, but these seem to be fished only by holidaymakers for personal consumption. Regular settlement does not occur in these bays and survival is not reliable; for example, there are several reports of the disappearance of potential cockle beds in Oxwich Bay.

Swansea Bay from the Mumbles in the west to Port Talbot in the east has a wide littoral zone, up to more than a mile wide at the estuary of the River Neath, which narrows along the exposed coast from

Port Talbot to Porthcawl. At Mumbles there is a large area of soft mud, but otherwise the shore slopes gently to low water and is predominantly of sand with some surface silt. The sublittoral zone of this area was until the 1920s the site of a flourishing oyster fishery, but there is no record of a regular fishery for cockles in Swansea Bay. A large settlement of cockles was recorded by Wright (1921a) for 1920, while some cockles were found there (prior to the cold spell in the early months of 1963) by the staff of Swansea University College. Wright (1927) described the Swansea Bay cockle beds as of an ephemeral character compared with the more stable beds of Carmarthen Bay, and subject to depopulation through storms and frost. The rivers running into Swansea Bay do not have wide inner estuaries like those of Carmarthen Bay and are believed to carry industrial waste.

The Taf-Towy Inlet: Of the two Carmarthen Bay inlets the one formed by the three rivers is the least stable, due mainly to sudden alterations of the River Taf. The course of this river is apparently influenced by the amount of fresh water passing Laugharne in the late winter and by spring tides in the summer. Locally, the Taf is said not to have a regular regime and this view is supported by the South-West Wales River Authority (C. C. Evans, Chief Engineer, pers. comm.) who state that the course of the River Taf alters frequently. Very substantial landings of cockles were made from within this area, regularly exceeding those recorded from the Burry Inlet, until the early 1930s (Table 2, recorded by the railway stations of despatch, Laugharne and Ferryside). Wright (1921b) mentioned that he found the cockle beds of Laugharne to be in a fairly thriving condition during his November 1921 visit, but went on to say "From evidence gained locally, and personal observations, it can be definitely stated that the local beds are subject to great destruction through the frequent alteration of the river channel. So great is the havoc at times that whole beds are said to be destroyed". Commander Gibson (Clerk and Chief Fishery Officer to the South Wales Sea Fisheries Committee) suggested that the River Towy and possibly also the Taf, changed course during the mid-1930s, with the result that several banks protecting the mouth of the Inlet were washed away. In recent years cockles which settled at Ferryside have been washed up at high-water mark by winter gales.

In July 1963, the Taf was running about east-south-east from Laugharne along the southern end of Wharley Point (Figure 2). Almost a mile of littoral zone, an area of fairly fine sand sloping slightly to the river with numerous run-off rills meandering through the sand, was exposed extending northwards from Ginst Point. A tremendous spatfall had occurred over almost all the area to the north and west of Ginst Point, with heaviest concentrations in the low-lying silty areas adjacent to the rills, an area also densely colonised by the small burrowing amphipod, *Corophium*. A small but highly concentrated bed of year-old cockles was located in a former river bed, close to the embryo saltings on the south side, between $\frac{1}{2}$ and $\frac{3}{4}$ of a mile south of the present course of the river. These cockles were all below legal minimum size ($\frac{3}{4}$ inch—see Appendix I) and the two local gatherers were fishing at Llanelly, over 30 miles away.

Facing the Taf estuary is the River Gwendraeth and here, too, the course of the river is liable to change, presumably in response to increased flow, but not, it seems, as frequently as the River Taf. The high bank of fine slightly silty sand about $\frac{1}{2}$ mile wide and 1 mile long to the south of the present course has not, except for 1961 when gatherers from Penclawdd fished there, carried an abundance of cockles for some years, to the detriment of the few remaining women gatherers from Llansaint who, since they only have donkeys for transport, are totally dependent on local stocks. There was, however, in common with other areas, a good settlement of cockles in 1963 and these were being fished by the Llansaint gatherers in 1965.

The River Towy, running almost due south, is again somewhat unstable, though cockles normally occur in moderate densities on the west side of the estuary from Llanstephan southwards to Wharley Point and, on the east, from Ferryside southwards for a mile or so (Figure 2). In July 1963, the littoral zone of the western bank was almost twice the width of that of the opposite shore but the only adult cockles on the Llanstephan side were found in the area just above Wharley Point. These, all two-year-olds,

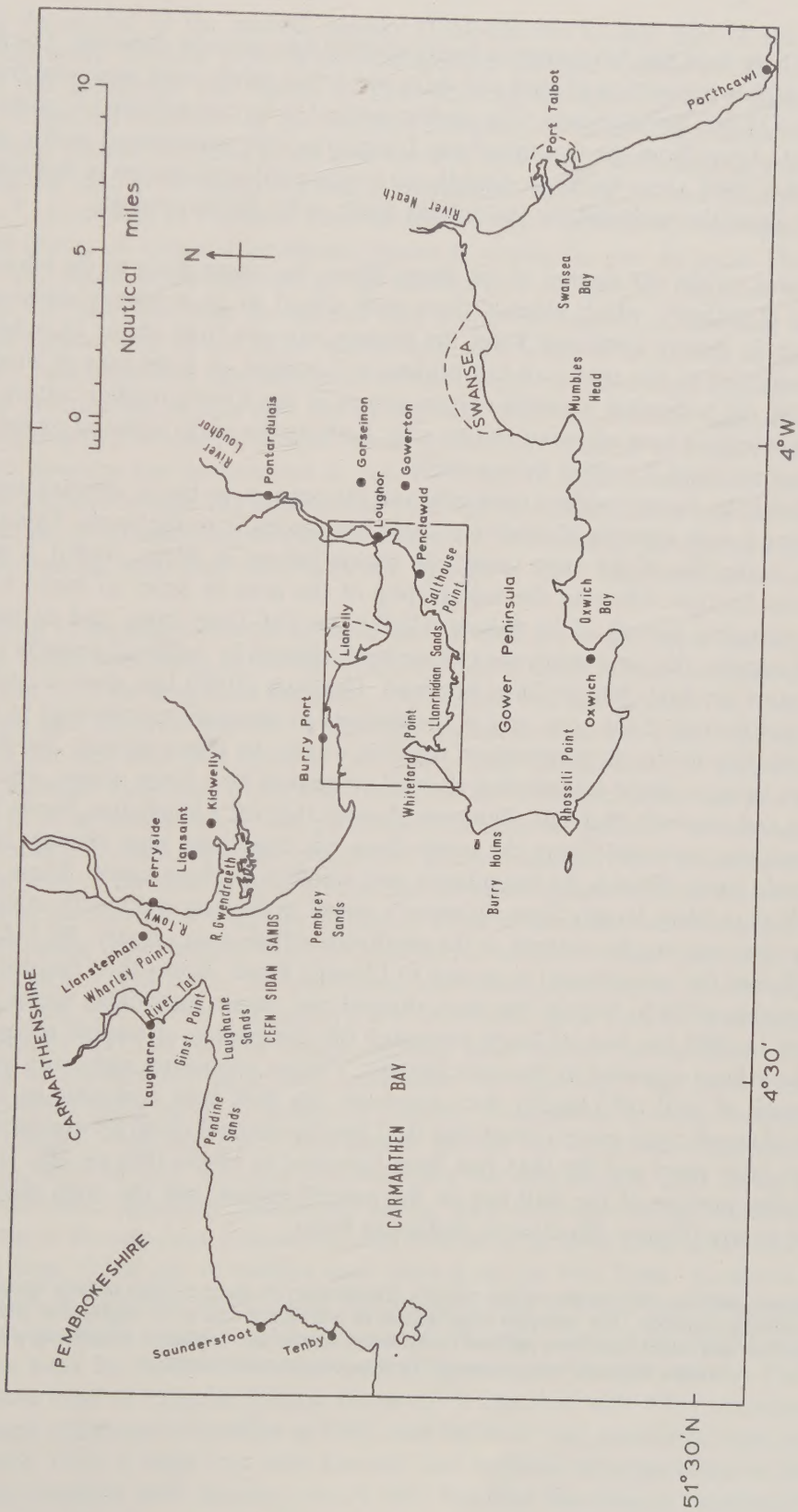


Fig. 2. *Outline map of the South Wales coast (from Admiralty Chart No. 1179); the Burry Inlet has been boxed in.*

were thinly spread, but here as in the Taf estuary a heavy spatfall had recently occurred. The sand in this area contained a much higher proportion of mud and there was a thin brittle crust separated from the firm substratum by 3-4 inches of thin liquified mud. The cockles seemed to be concentrated in pools formed by breaks in the hard crust. Apart from the two men from Laugharne who commenced cockle gathering at Llanstephan in November 1964, there has been virtually no commercial exploitation in this area in recent years, except for small quantities gathered for the holiday trade or by holidaymakers.

The Burry Inlet: This area covers the estuary of the Burry River, the name given to the seaward section of the River Loughor (Llwchwr), which extends from well inland to an arbitrary division at about Salthouse Point (Figure 2). Above Salthouse Point the estuary narrows from about 1½ miles wide to ½ mile wide, before constricting at the road and rail bridges at Loughor. A large area of muddy sand is exposed at low tide, with the somewhat unstable narrow course of the River Loughor cutting through it. Occasional settlements of cockles have occurred in this area, both on the north side and on the south, but in recent years there has not been a regular fishery there.

Below Salthouse Point the estuary widens markedly and the main river bed is directed more towards the northern side, leaving a wide expanse of relatively stable flat sandbank to the south. This area, known as Llanrhidian Sands, is the site of the most important cockle fishery in Wales, and it is necessary to understand any physical changes affecting the topography of the area in order to make a reasonable interpretation of the changing pattern of its fishery. Unlike the Taf-Towy inlet, and as the figures of landings (Table 2) also suggest, this area seems not to have been affected by *sudden* changes in topography, though undoubtedly more gradual changes have occurred. Plummer (1960) has given a comprehensive account of the geological history of the area, and of the changes in estuarine morphology in more recent times, particularly in relation to the development of marshes within the upper estuary. He described the river above Llanelly as being a single meandering channel compared with lower down, where there are numerous meandering and evasive* channels. Plummer showed that the Llanrhidian Sands have always been a large continuous area accessible from the south shore but there have been changes in the course of the river which would have affected the boundaries and stability of these sands. These changes are shown in Figure 3, which is taken largely from Plummer's work. In the late eighteenth century it would appear that the regime was moving the channel to the north side of the inner estuary. By 1862 this movement had adversely affected the navigational approach to Llanelly Dock. It was then decided by the port authorities to build training walls to contain the main channel and ensure reasonable access to the dock. The works commenced in 1882 but lack of funds prevented the completion of the full scheme, in which parallel walls would have been extended to the outer estuary. Various extensions and spurs were added to the original short stretch of wall off Llanelly dock entrance, the final spur commencing in 1910. The evasive flood and ebb channels were never united and the Llanelly channel silted up eventually. The wall was not maintained in later years and by 1945 had been breached in places (Figure 3E). It is not clear what effect the remaining portion of the wall has on the present regime, but the main channel has not returned to its former course (Figure 3B) close to Salthouse Point.

*"evasive" refers to channels carrying either water of low salinity downstream or water of high salinity upstream, which do not converge but form separate channels. The essential requirement of a training wall is to ensure that the ebb and flood use the same channels and this aim might have been realised in the Burry Inlet if the extension of training walls to the outer estuary had not been prevented by financial considerations.

During the period of the present surveys (1958–65) the central part of the estuary has, however, changed noticeably. During 1958–59 the southernmost channel moved south, eroding the Llanrhidian Sands, but this movement had ceased by 1960–61, and was followed by a northward movement. This resulted in a marked extension of the northern boundary of Llanrhidian Sands, and in 1963 part of the former channel became included in the area covered by a heavy settlement of young cockles.

Fringing the land to the south is a belt of marshland thinning out to a zone of *Salicornia* and clumps of *Spartina**. According to Plummer there has been a rapid extension of marshland along the western end of the south shore, i.e. Llandimore Marsh (Figure 4), during the past 80 years. This, he said, was due less to natural salt marsh accretion than to the introduction of *Spartina*. Between Weobley Causeway and Llanrhidian Pill there was little change and only slight colonisation of *Spartina*, due mainly to the main ebb channel approaching nearer to the marsh front as a result of the breach in the training wall in 1945. Before 1945, Penclawdd Salt Marsh (Figure 4) was rapidly extended after the construction of the training wall and by colonisation of *Spartina*, but in this area there was by 1960 slight marsh retreat (Plummer, 1960). According to Plummer, the rapid marsh growth has resulted in a loss of tidal volume within the estuary, and *Spartina* has commenced to colonise areas of quite considerable tidal flow. He considers that because the environment has thus become modified the marsh front is now less likely to become eroded as a result of any southward movements of the channel. Nowhere do the *Spartina* clumps extend on to the main cockle-bearing areas and there does not appear to have been any rapid extension between 1958 and 1964.

The estuary of the Burry River is so silted up that even 3-4 hours before low water most of the area of Llanrhidian Sands is exposed, revealing a vast expanse of sand intersected by drainage channels or pills (Figures 4 and 5). Two large deep channels, Llanrhidian Pill and Leason Pill, run out from Llanrhidian Marsh to join near the river bed into which they discharge. Both are quite unstable—Leason Pill moved 100 yards to the west and back again in two years, while Llanrhidian Pill moved several hundred yards to the east. Another large pill, Burry Pill, runs close to Whiteford Point and several small channels discharge into it. A series of more or less permanent channels or "gutters" not connected with the land are present and they and many other less permanent gutters facilitate rapid drainage of the sand table on the ebb tide. The level of the sand table is several feet above mean tide level, as shown in the profile in Figure 6. Although at low tide something like 20 square miles of sand and mud are exposed in the Burry Inlet, the beds containing commercially fishable densities of cockles occupy little more than one square mile.

The north shore (Figure 4) is far less stable, and although statistical records show substantial catches between 1910 and 1922 (Table 2, Llanelly), it is likely that these cockles were taken on the south shore and despatched by rail from Llanelly station. An early Sea Fisheries Annual Report (1887, p. 57) mentioned 26 fishermen at Llanelly but gave their occupation as "trawling"; the same report (p. 32) recorded Penclawdd cockles being taken to market at Llanelly. Cockles do however frequently settle in the area close to the Llanelly, Pwll and Burry Port shores. In 1961 the north shore received a heavy settlement of cockles which survived well not only for two years but surprisingly, also during the winter of 1962–63 when beds elsewhere, including Llanrhidian Sands, were decimated by the severe conditions. As a result gatherers came to the area from Penclawdd, and even as far as from Laugharne, and between January and June 1963 at least 10 000 cwt of cockles were lifted from the Pwll Bank. Access to the Pwll Bank is less convenient than to the south shore, being restricted on foot to a short period around low-water time, or at other times by dinghy across a dangerous stretch of water. During the period of fishing in 1963 severe erosion of the bank by the river was also occurring, and it is thought that the Pwll area is never likely to support more than an irregular fishery. However, in common with other areas locally, the north shore received a heavy settlement of cockles in 1963, and the beds were providing large catches of good quality cockles by early 1965. A large area near Llanelly had acquired an appearance of greater stability due to changes in the northern river channel, and in 1965 this area was densely populated by cockles.

* *Spartina* is said to have been introduced into the Burry Estuary in 1931 (J. C. E. Hubbard, pers. comm.).

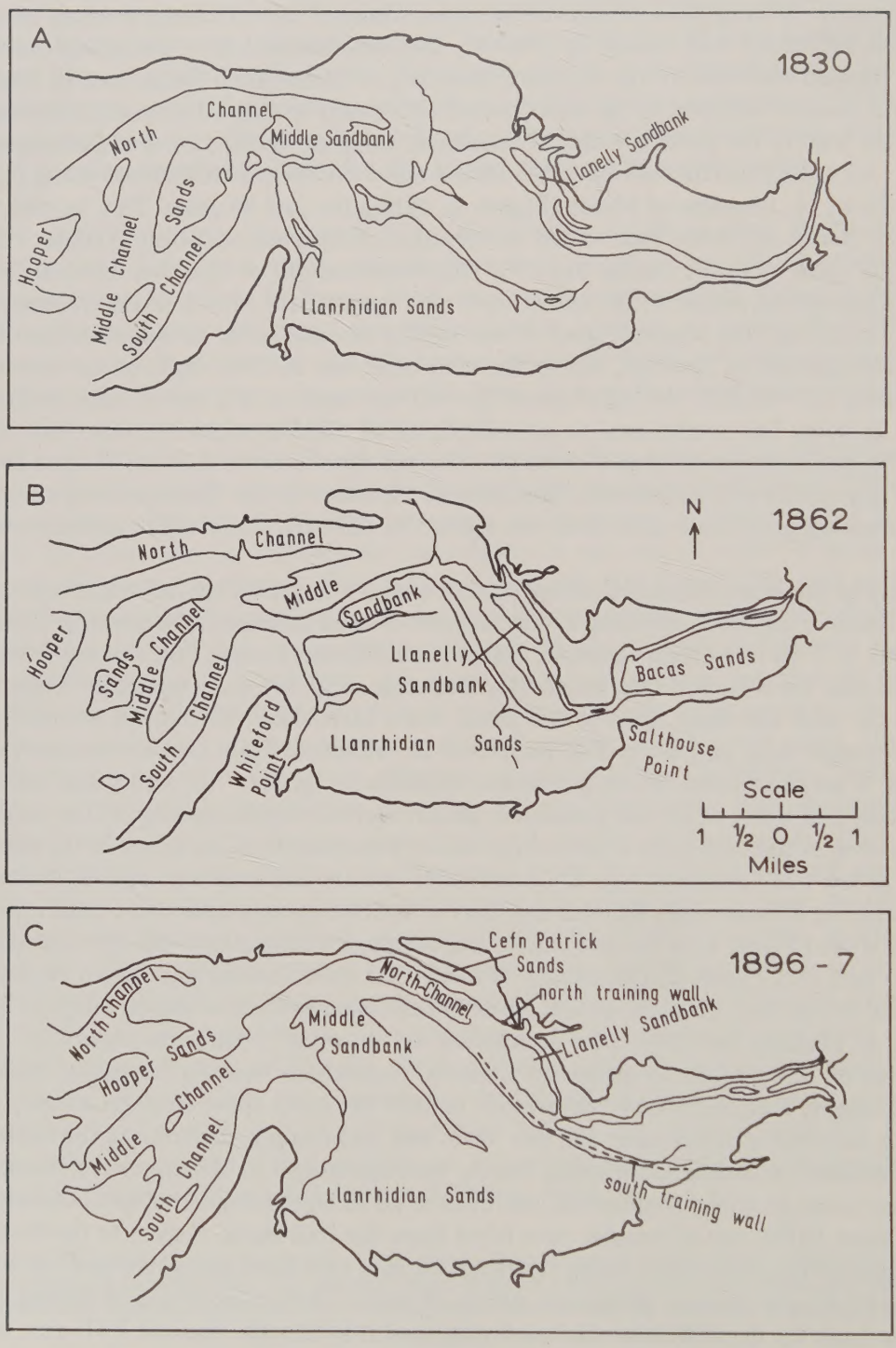
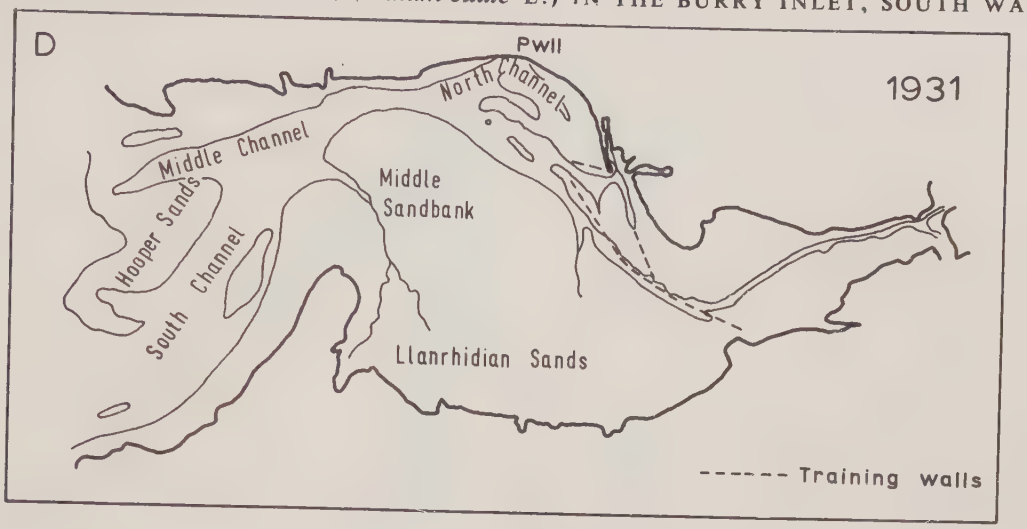
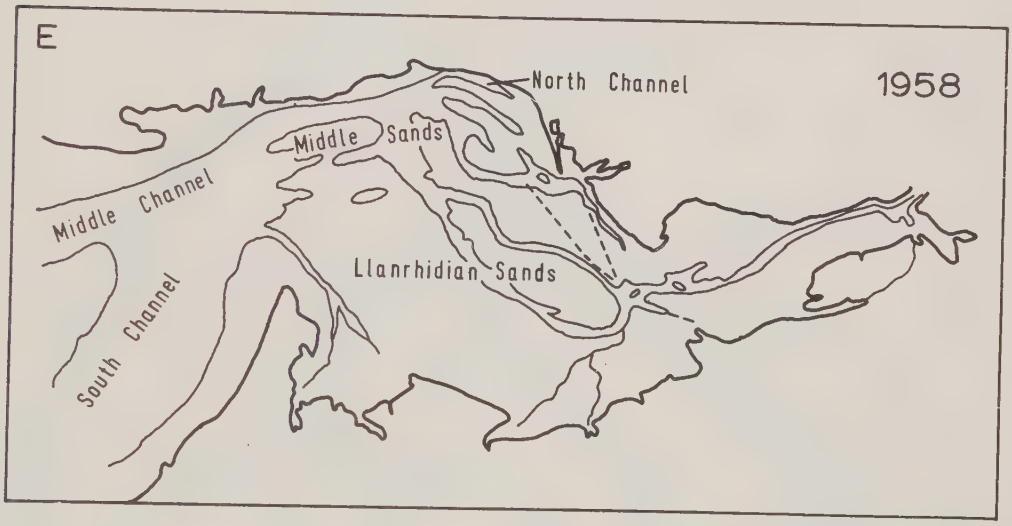
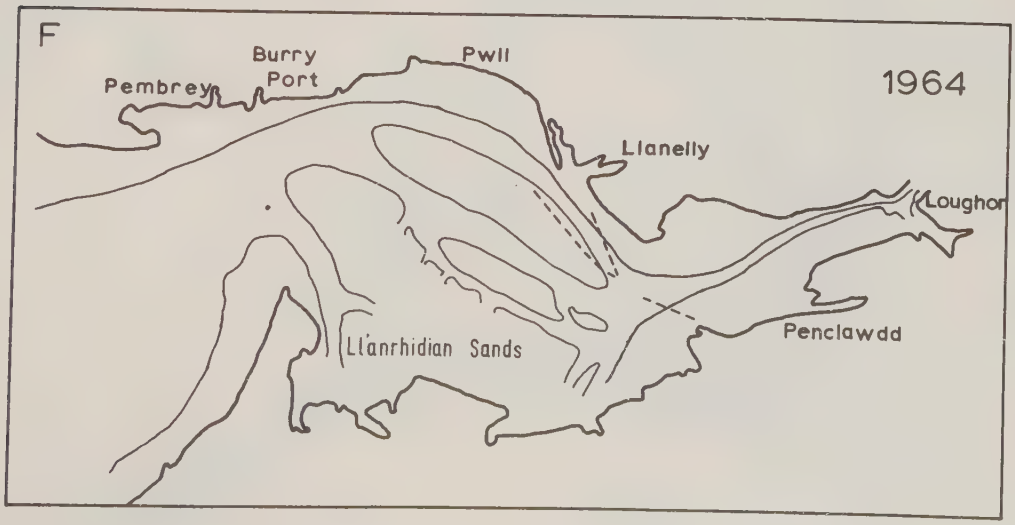


Fig. 3. *Diagrams illustrating changes in the course of the main river channels in the Burry Inlet*, 1830-1964. *Diagrams A-E from Plummer* (1960).


D
Pwll
North Channel
1931
Middle Channel
Middle Sandbank
Hooper Sands
South Channel
Llanrhidian Sands
------ Training walls


E
North Channel
1958
Middle Sands
Middle Channel
Llanrhidian Sands
South Channel


F
Burry Port
Pembrey
Pwll
1964
Llanelly
Loughor
Penclawdd
Llanrhidian Sands

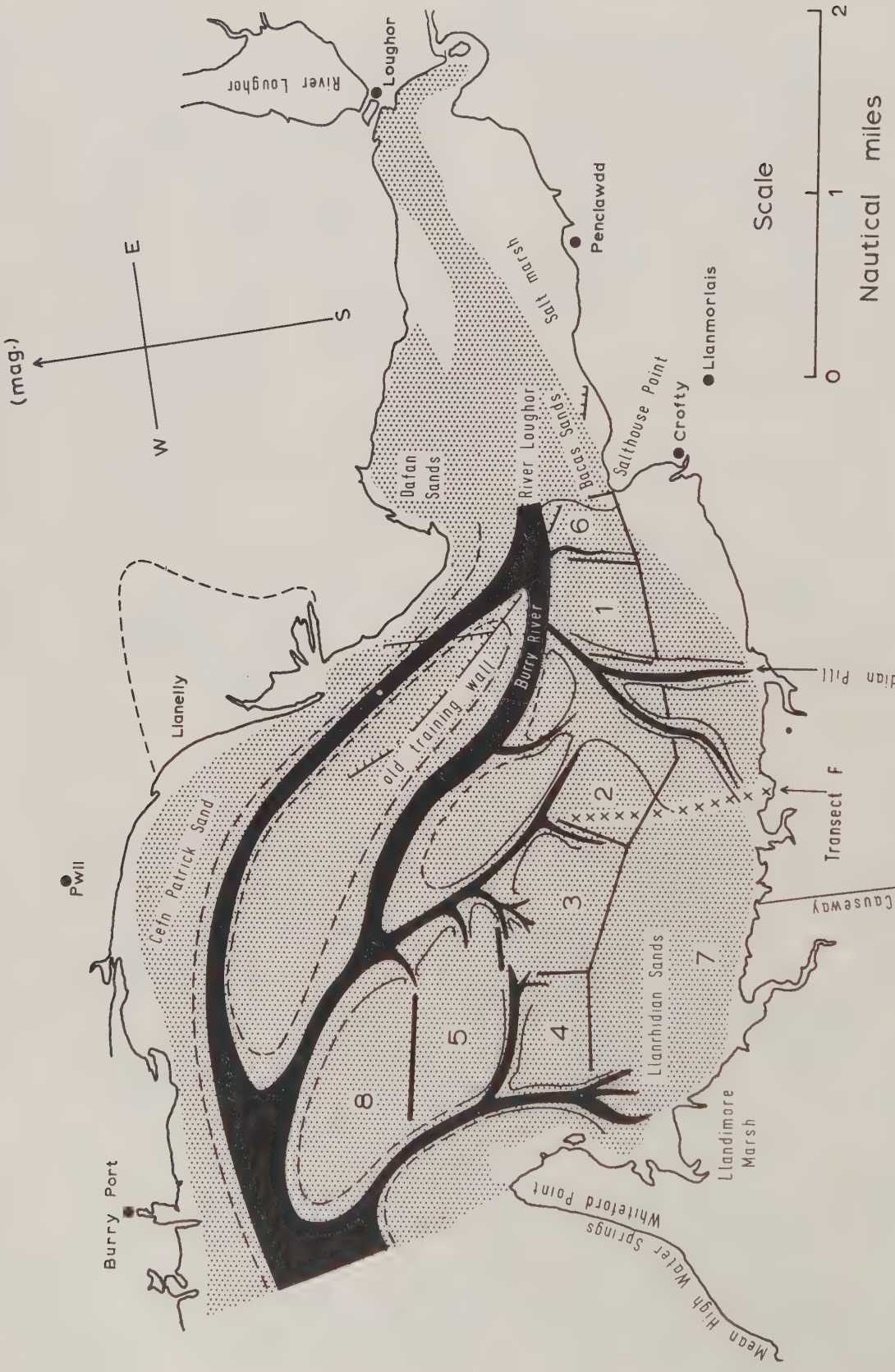


Fig. 4. *Chart of the Burry Inlet, modified from Admiralty Chart No.* 1167, *showing the sub-areas of Llanrhidian Sands described in the text. The position of the shore profile in Fig.* 6 *is shown by* xxx.

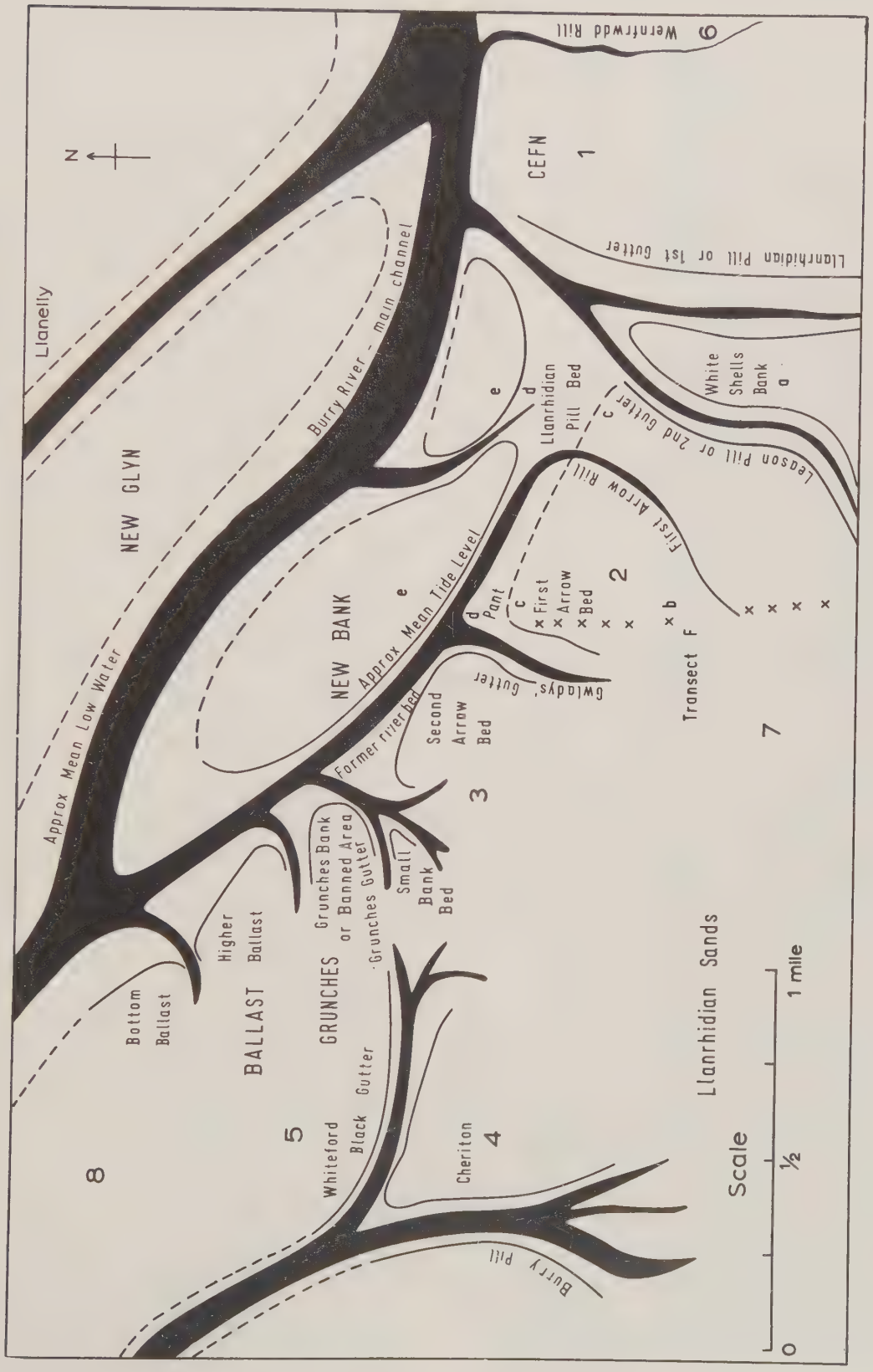


Fig. 5. *Distribution of the main drainage channels on Llanrhidian Sands, together with the local names of cockle beds referred to in the text.* (*To be used in conjunction with Figure* 4.) *A broken line indicates that the position of the edge of the bank is ill-defined or estimated.*

Table 1. *Descriptions of sub-areas* 1-5 *of Llanrhidian Sands shown in Figure* 4.

	Sub-area 1	Sub-area 2	Sub-area 3	Sub-area 4	Sub-area 5
Substratum	Fine sand with a little silt to south, coarser silty sand to north	a) very silty fine sand b) cleaner fine sand c) fine/medium sand d) fine muddy sand e) hard packed coarse sand	Clean fine sand becoming coarser to north, fine silty sand associated with Grunches Gutter	Mainly fine sand with silt, and a high bank of soft frothy coarse sand	Mainly clean medium sand, becoming coarser to north and east. Cenral patch of gravel and mussel shell
Amount of dead shell on or below surface (ml per 1/10m^2)	Surface: occasional	Occasional, but abundant on large shell bank running across centre	Occasional to frequent	Occasional	Occasional to frequent
	Surface+below: 0-400	0-400 ml generally, but 800 to >1 200 associated with shell bank	400-1 200 ml	0-800 ml	0-800 ml
Anaerobic Layer (May)*	Near surface in shell bank and along Llanrhidian Pill, but more than 12 inches deep nearer river	½—1½ inches below surface except on the new banks alongside the course of the river	1½—2 inches below surface. Sub-surface shells blackened in west, cleaner to north	1½—2½ inches below surface	1½—2½ inches below surface, becoming grey, not black to the north
Enteromorpha	Some along southern edge	Abundant, centrally and to north west	Small amount all over	Small amount all over, with more centrally	Small amount all over with more centrally
Zostera	None seen	Infrequent	Frequent and extensive	Infrequent	Frequent over whole area

Table 1. *Descriptions of sub-areas* 1-5 *of Llanrhidian Sands shown in Figure* 4. **(*Continued*)**

Arenicola	Widespread	Widespread	Frequent to west and in Grunches Gutter, occasional in east	Widespread, except to west	Widespread
Mussels	Some along southern edge	In south-eastern and north-western corners	A few south and west	Abundant in "crumbles" in north-eastern corner	Small area of "crumbles" to north-east
Winkles and barnacles	On posts and in pools	Associated with mussels and on posts	With mussels	With mussels	With mussels
Corophium	Some in south-western corner	In south-eastern corner and muddy areas of Gwlady's Gutter	Few	None recorded	Few
Shore Crabs (*Carcinus*)	Small (5-9 mm) all over area	Small, less than 13 mm over whole area	Small, all over area, 3-17 mm	Fair numbers of small crabs especially amongst mussels	Small (5-16 mm) all over area
Macoma Mean density per square metre May 1958-May 1965	440	300	150	70	50
Scrobicularia	Fair numbers in south-western corner	Fair numbers in centre and south-east	Fair numbers, mainly in Grunches Gutter	Only 2 recorded	Few

*This level is likely to vary with the time of the year (Brafield, 1964)

DETAILED TOPOGRAPHY OF LLANRHIDIAN SANDS

DURING the course of transect surveys of Llanrhidian Sands from April 1958 to May 1965, the quantitative results of which will be given in a later publication, records were kept of the important features characterising each part of the sands, including the composition of the surface and its flora and fauna. For the purpose of this description the area surveyed regularly has been sub-divided into five arbitrary sub-areas conveniently bounded by various pills and gutters (Figures 4 and 5).

Commencing at the eastern end, the sub–areas cover:

1. Wernfrwdd Rill to Llanrhidian Pill
2. Llanrhidian Pill to Gwladys' Gutter
3. Gwladys' Gutter to the rills of Black Gutter
4. Rills of Black Gutter to Burry Pill
5. Grunches Gutter to Burry Pill.

In addition, sub-areas 6–8 are described but were not included in the area covered by detailed sampling. The southern boundary of sub-area 1 was put at about $\frac{1}{2}$ mile, of sub-area 2 at from $\frac{1}{2}$ to 1 mile, and of sub-areas 3 and 4 at about 1 mile, north of the saltings.

Only brief comments on each sub-area and the distribution of important animal and plant species are made in Table 1, but a full fauna and flora list will be given in a later publication in this series. The remarks concerning the anaerobic layer refer to limited observations on the depth at which the blackened layer of sand occurred in May 1964. This results from deoxygenation in badly drained beaches, and the production by bacteria of black iron sulphides; the position of the black layer has been found in other areas to be nearer the surface in summer (Perkins, 1957; Brafield, 1964).

Sub-area 1. Here the shore slopes regularly from south to north into the river and has a surface of fine sand containing a little silt inshore but becoming a slightly coarser silty sand northwards towards the river. A few rills have been forming on the western edge in association with Llanrhidian Pill. There is a small slightly raised bank covered by cockle shells just to the east of centre but otherwise shells are only lightly scattered on the surface. A few stumps still remain in this area from the many large posts erected for anti-invasion purposes during the 1939–45 war, and pools are left around their bases by the ebbing tide. The course of the small pill (Wernfrwdd) at the eastern boundary has been known to change but the effects of this have not been noticeable during the surveys. Two important changes which have however occurred in this area are the movement of Llanrhidian Pill by about 300 yards to the east during 1961 and 1962, and the northward movement of the main Burry River by about 100 yards during the same period. Sub-area 1 is likely to have more than average tidal exposure, since it is farthest away from the estuary mouth and situated only half a mile or so from mean high water of spring tides, and in some places just over a quarter of a mile from the saltings.

Cockle settlement here tends to be irregular, though heavy spatfalls in 1961 and 1963 support the view that there is a trend towards more regular production in this area.

Sub-area 2. This is less uniform than any of the other sub-areas, being deeply divided by Leason Pill in the south-eastern corner and by a large drainage rill, First Arrow Rill, which runs approximately from south to north through the middle, turning to the north-west in the old river bed and running alongside the large sandbank which forms the northern boundary. At the western edge lies Gwladys' Gutter (Plate 1). The portion enclosed by Leason and Llanrhidian Pills in the south-eastern corner has a tendency to the formation of "crumbles"—this is the name given locally to fairly large clumps or hummocks of shell bound together by mussels (Plate 4). Pools have formed between clumps of mussels and the surface is quite muddy and anaerobic just underneath. Close to Leason Pill is the White Shells Bank (Figure 5,

Sub-area 2, a) so called because of its thick covering of empty cockle shells bleached by the sun. North of Leason Pill the shore slopes down to the now barely perceptible ridge that was once the steep edge of the former river bank. A depression of about 500 yards of silty sand (Sub-area 2, d), representing the old river bed, separates a high bank of clean hard sand (2, e), about 300 yards across, from the main sand-bank. The course of the main river here was displaced about 600–700 yards to the north between 1958 and 1964.

The western half of the sub-area, between First Arrow Rill and Gwladys' Gutter, has a fairly even surface sloping gently downwards from south to north, with only a few surface shells except close to the old river bank, and containing fine to medium sand (Sub-area 2, b and c). The old river bed is of fine muddy sand (2, d), while coarse hard-packed sand forms the new banks (2, e) between it and the Burry River.

Each year this sub-area receives a fairly good settlement of cockles, particularly over the central part, with the heaviest settlement almost always concentrated along the muddy banks of Gwladys' Gutter. The new stability of the old river bed here is emphasised by the heavy spatfall of cockles it received towards the eastern end in 1963, while the western end, although it received few spat, developed into a useful bed of cockles believed to have been washed there from crowded beds elsewhere.

Sub-area 3. Between Gwladys' Gutter and the eastern tributaries of Grunches Gutter (Plate 2) is a stable plateau bounded by a steep drop to the old river bed to the north. The surface is composed of clean fine sand in the south, becoming coarser towards the northern boundary. Moderate amounts of shell are present all over the area, with more on the old river bank. There is a large somewhat unstable area of fine silty sand covered by rills associated with Grunches Gutter. The course of the main gutter remained unchanged during the surveys. Along the north-eastern edge of this sub-area the former bed of the Burry River swings northwards, followed by a wide sweep round to the west. Changes in the position of the river channel which were so marked in the eastern sections also occurred here but were not evident until 1963. The western part of the area is covered by a uniform stretch of fine sand sloping gently downwards to coarser sand in the north. There are moderate numbers of shells scattered over the surface.

Good cockle settlement generally occurs over the eastern and northern parts of this area, the maximum densities being associated with the Grunches Gutter complex.

Sub-area 4. The southern part of this area has been invaded by clumps of *Spartina* (Plate 3), and a large number of rills occupies most of the eastern side. In the northern half there is a high bank of soft coarse sand about 100 yards wide adjoining the large area disturbed by Black Gutter to the north. At the western edge the Burry Pill, a deep channel about 20 yards wide, flows quietly by. After 1958 its eastern bank was eroded by about 50 yards but this movement appeared to have stopped by 1963. The remaining central area has an uneven surface of fine sand, slightly silty, with small pools left behind by the tide.

Commercial densities of cockles occur in most years in the central and western parts of the area, with occasional settlements among the rills towards the eastern edge.

Sub-area 5. The southern edge of this sub-area is somewhat disturbed by the proximity of Black Gutter which seems to encourage violent eddies on the flood tide. During 1959, the bed of the gutter itself was broken by large deep naturally-formed holes with unstable sides, and an unpleasantly close, but brief, observation on the flooding into this gutter confirmed its turbulent action. Between 1959 and 1964, however, Black Gutter has reduced in extent and assumed a quieter aspect. The mussel "crumbles" at the eastern end of the gutter have been a permanent feature since 1958, with no apparent change in extent or density (Plate 4). The river bank which forms the eastern limit of this sub-area has altered slightly from year to year, especially near the two run-off rills north of Grunches Gutter. The bank has changed from a steep drop to the river in 1958 to a long shallow slope in 1963. In common with other areas, the Grunches

Bank (often referred to locally as the "Banned" area) has undergone a series of changes of surface appearance, associated with the settlement of cockles and their exploitation. In early 1958, this area contained few cockles and was composed of soft coarse sand covering many underlying shells. During that summer (1958) there was a dense settlement of cockles. By the following year mussel "crumbles" had developed along the southern and western edges, while the main bed became composed of damp firm sand with many surface shells covering a dense population of cockles. After intensive fishing, the surface reverted to soft rippled sand with shells, and the mussel "crumbles" disappeared. There was no further substantial settlement here, except along its southern edge, until 1963.

Clear of the disturbed boundaries is a vast expanse of clean coarse sand extending well beyond the arbitrary northern limit. There is a barely perceptible slope downwards from south to north with only occasional shells scattered over the surface. A small discrete patch of gravel and mussel shell fragments occurs in the centre of the area.

Cockle settlement has occurred in varying quantity each summer since 1958, tending to concentrate close to the southern and eastern boundaries, leaving the north-west corner more or less barren. The growth rate of cockles is markedly higher than in any of the other sub-areas, reaching a maximum in the north-eastern corner.

The parts of Llanrhidian Sands not covered by the transect survey include:

Sub-area 6. This extends eastwards from sub-area 1 and has a similar appearance to it. Like the remainder of Llanrhidian Sands it is said to have received a heavy spatfall in 1963.

Sub-area 7. Between the area surveyed and the saltings to the south is an area of upper shore which extends from Salthouse Point westwards to Llandimore Marsh. Between mean high water of spring tides, and roughly, mean high water of neap tides there are patches of *Spartina* hummocks (Plate 3) spreading out from the saltings to the junction of sub-areas 2 and 3 and along the southern boundary of sub-area 4. This latter patch has not grown out from the north but its extension east and west has surrounded a clear area of fine sand in front of the saltings. There is a persistent bed of *Salicornia* along the southern edge of sub-area 1, visible each summer, over an area covered by hummocks of sand intersected by numerous rills.

Sub-area 8. The large expanse north of sub-area 5 is composed of clean coarse hard sand forming parallel ridges two or three feet high and six feet apart (Plate 5). These ridges are almost certainly formed as a result of tidal action, and the area, which contains few large cockles, is seldom, if ever, fished commercially. To the west of this sub-area the course of Burry Pill north of its junction with Black Gutter has not been mapped accurately, though it can be seen to swing round westwards to Whiteford Point.

The north-western part of this area was subjected to sand and gravel dredging by boats working out of Llanelly during 1963 and 1964. As a result of representations by the South Wales Sea Fisheries Committee, the dredging companies agreed to confine their activities to the sandbanks on the seaward side of Whiteford Point. No information was available on the quantities of sand removed or on the precise areas of Llanrhidian Sands from which they were taken, but it was felt that workings so close to the cockle beds, which were less than one mile away, might be harmful on two counts: (1) because of increased sediment circulation, particularly of the fine fraction, caused by the actual dredging operations, and (2) continued extraction of large quantities of material might cause alterations in the shore profile locally, and perhaps lead to long-term alterations of the channel pattern and affect the stability of the cockle beds.

Plate 1. *Gwladys' Gutter opening in the Burry River, a site for regular heavy cockle settlement. A flock of oystercatchers has been disturbed along the edge of the rising tide.*

Plate 2. *Clean, firm sand over Second Arrow Bed (Sub-area 3) showing Grunches Gutter, with Grunches Bank in the left background. There are a few small piles of broken shells left by feeding oystercatchers.*

Plate 3. Spartina *hummocks below Weobley Castle* (*Sub-area* 4).

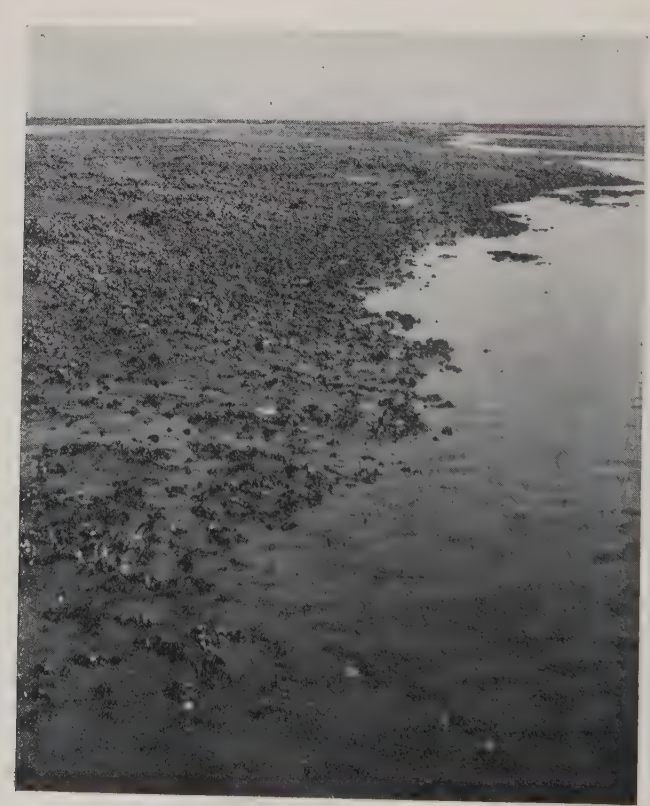


Plate 4. *Mussel "crumbles" along the northern bank of Black Gutter* (*Sub-area* 5).

Plate 5. *North-western part of Llanrhidian Sands (Sub-area 8) showing ridged sand and pools, with Whiteford Point and Lighthouse in the background.*

Plate 6. *A specially constructed hand dredge sometimes used in the Burry Inlet.*

Plate 7. *Llanrhidian Sands cockle gatherers waiting on the ebbing tide to cross Llanrhidian Pill on to the main cockle beds.*

Plate 8. *Llanrhidian Sands cockle gatherers with one of the few remaining donkeys used to transport the catch.*

Plate 9. *Cockle gathering on Llanrhidian Sands.*

Plate 10. *Sieving cockles on the Pant area.*

Plate 11. *The cockle catch is usually washed in a convenient stream.*

Photo: by courtesy of "The Guardian"

Plate 12. *Sacks of cockles ready for processing at a communal boiling plant.*

Plate 13. *Three steam cookers inside a boiling plant at Penclawdd.*

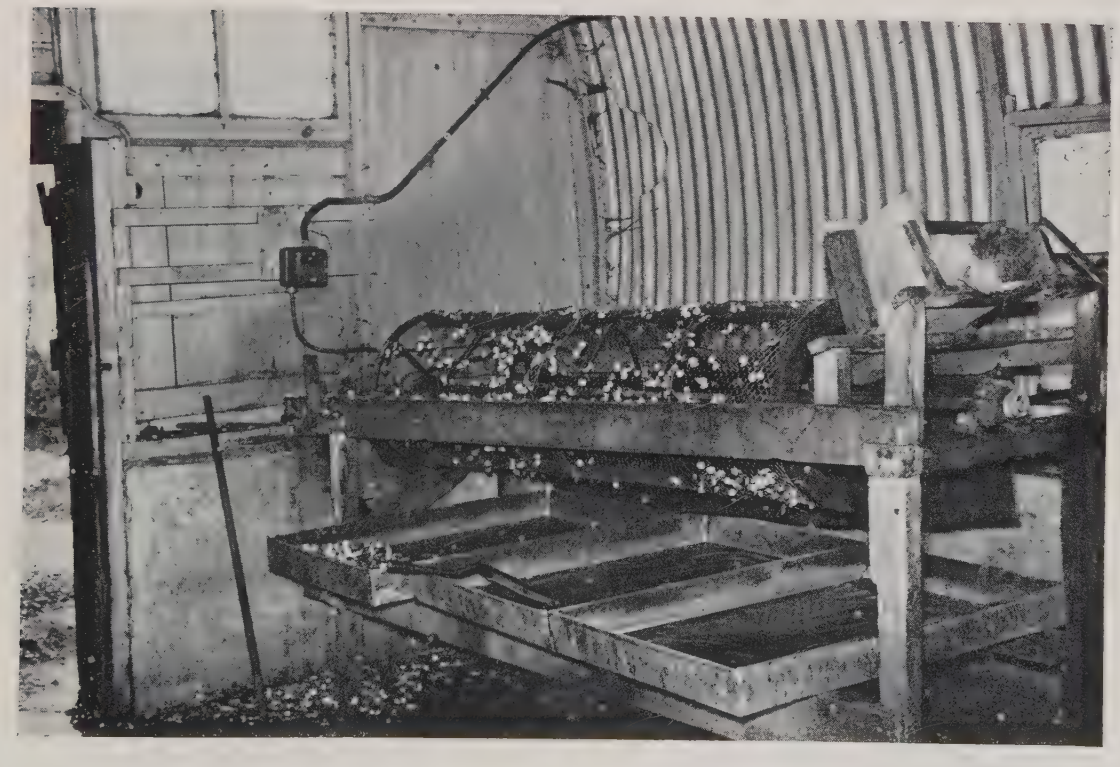


Plate 14. *Revolving wire screen used for separating cockle meats from the shells at Penclawdd.*

Plate 15. *Washing the cooked cockle meats at Penclawdd.*

Plate 16. *Preparing the cockle meats for market.*

TIDAL HEIGHTS OVER LLANRHIDIAN SANDS

REED'S Nautical Almanac for 1964 gave the height above chart datum as 25 ft (7½ metres) at mean high water of spring tides, and 18 ft (5½ metres) at mean high water of neaps. Llanelly Dock Board Tide Table, 1964, gave the extreme high water level of spring tides (EHWS) as 27·3 ft in April and the lowest high water level of neaps (LHWN) as 17 ft in October. High water of spring tides usually occurs between six and eight o'clock G.M.T., and high water of neap tides between twelve and two o'clock. Both the height and time of tide may be affected by the influence of prevailing meteorological conditions such as wind direction and barometric pressure. For example, in early November 1964 the height of a predicted good spring tide of 25 ft was reduced by more than 2 ft as a result of the combined effects of a north-easterly wind and a high-pressure system.

Using the relationship in Reed's Almanac 1964, p. 429, that:—

Height at low water = 2 × (mean level) − height at high water, where for Llanelly the mean level = 12 ft, it can be seen that

Height at mean low-water level of springs (MLWS) =
(2 × 12) − 25 ft = 1 ft below Admiralty chart datum,
Height at extreme low-water level of springs (ELWS) =
(2 × 12) − 27·3 ft = 3·3 ft below chart datum,
Height at mean low-water level of neaps (MLWN) =
(2 × 12) − 18 ft = 6 ft above chart datum,
Height at highest low-water level of neaps (HLWN) =
(2 × 12) − 17 ft = 7 ft above chart datum.

It follows that the tidal range varies from 27·3 + 3·3 = 30·6 ft at extreme spring tides to 17 − 7 = 10 ft at extreme neaps (Figure 6).

SHORE PROFILE AND ITS RELATION TO COCKLE DISTRIBUTION

IN May 1959, Dr. D. Maling of the Geography Department, University College of Swansea, kindly collaborated by taking levels of the shore at stations along one of the sampling transects established during our surveys (Transect F on First Arrow bed—Figures 4 and 5). His results are given in Figure 6, together with the various tidal levels discussed in the previous section. It can be seen that in the area chosen for survey the main cockle-bearing area occurred between mean tide level and mean high water level of neaps. This area would have been completely exposed by 2½ hours after mean high water of springs or 2¼ hours after mean high water of neaps. In May 1964 the approximate tide line of a high water neap predicted as 17·9 ft, i.e. high water of a mean neap tide, was seen to be close to the upper limit of cockle distribution on the shore (Stations F1–3 in Figure 6). Its position also approximated to the arbitrary boundary between sub-areas 1–4 and 7 in Figure 4. Cole (1956) also found cockles near high water of neap tides at Poole Harbour, but he considered that on the major cockle beds the greatest concentrations of cockles occur between mean tide level and low water of neaps.

The restriction of cockles to a relatively high level of the shore in the Burry Inlet is believed to be associated with the comparatively narrow width of the estuary, having a shore profile with a flat plateau at higher levels, with a fairly steep bank near mean tide level and a slope subject to tidal scour at its lower extremities. More recently, it has been seen how areas below mean tide level have also become colonised by cockles as stretches of the main Burry River have been deflected in a northerly direction. In other intertidal areas associated with wider inlets or the open sea, such as the Shoebury Sands in Essex, cockles

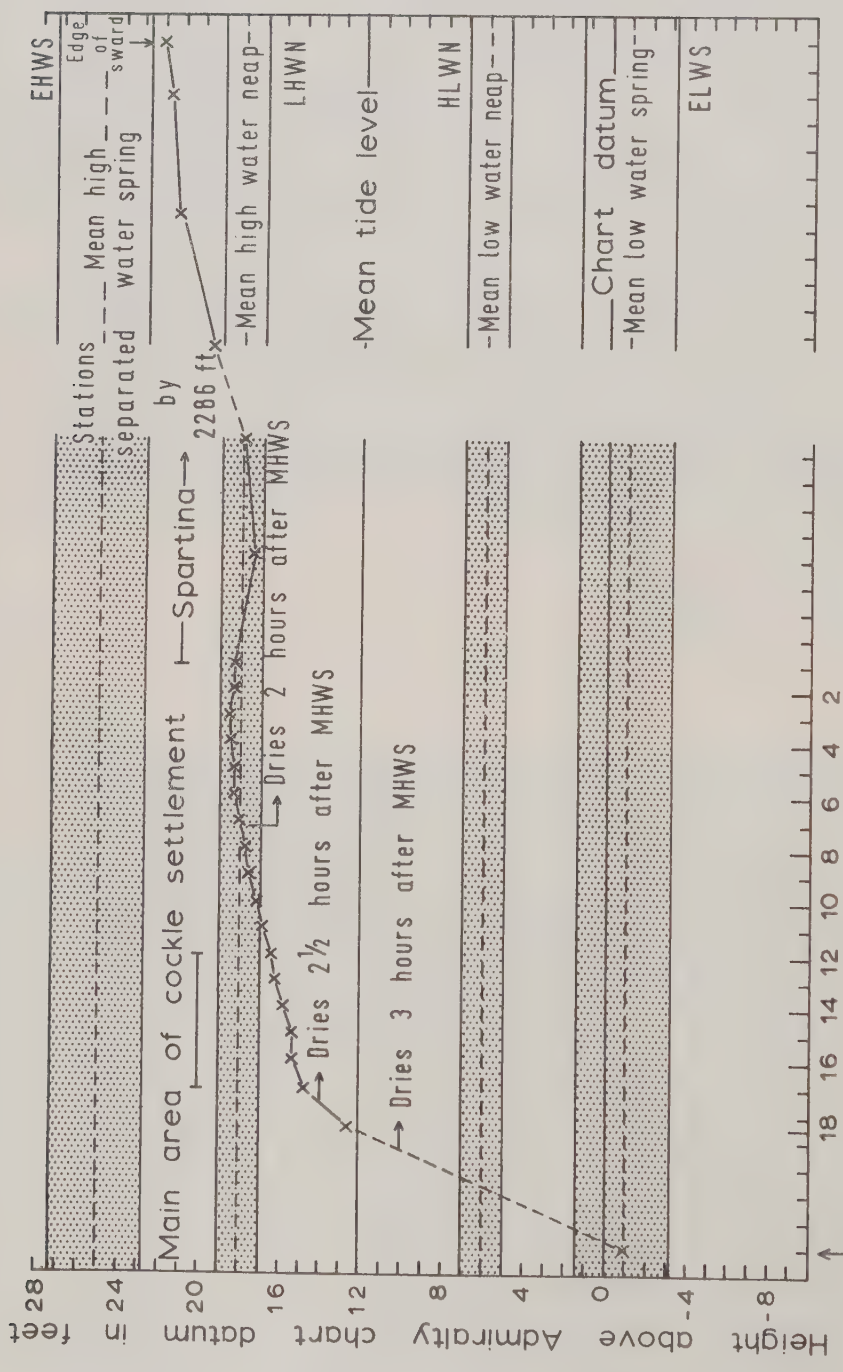


Fig. 6. *Diagram showing the shore profile of First Arrow bed (Transect F, sampling stations* 1-18*) and the main area of cockle settlement in relation to tidal heights. The shaded areas show the range of tidal height at high and low water of spring and neap tides; values taken from Llanelly Dock Board Tide Table*, 1964.

occur as far down as low water of spring tides, but here their distribution ends. Wright (1927, p. 20) also found that cockles occurred towards low-water mark on the Maplin Sands, which are a continuation of the Shoebury Sands. In view of occasional reliable reports, e.g. from off Rhyl in North Wales, it seems that survival of *Cardium edule* below low-water mark is possible, but the chances may be reduced by the possibility of 24-hour predation by those of its enemies (such as starfish and whelks) which do not penetrate far into the intertidal zone during high water, as well as by fish, crabs, etc., which do.

HISTORY OF THE COCKLE FISHERY

THERE seems to be little published information about the South Wales cockle fisheries before the 1880s, by which time a substantial fishery had evidently already been in existence for many years. Donovan (1805, *cit.* Matheson 1929) mentioned the partiality of the Glamorgan peasantry for cockles, for which they would dig in the sand. The Admiralty Chart dated 1862 shows the existence of a cockle fishery on Llanrhidian Sands. During the 1880s the biggest landings in South Wales seem to have come from the Burry Inlet. Davies (1885, p. 309) stated "The value of the cockles and mussels taken near the mouth of the Towy, and up to Ferryside, is estimated at about £6 000 a year. Further east, there are also cockle fisheries at Penclawdd, and near Llanelly, in which some five hundred families find employment, and the cockles and mussels taken are valued at £15 000 a year". In a special report (1887, p. 31) the Inspector of Fisheries said "At Penclawdd, opposite Llanelly, is a great cockle fishery which is wholly carried on by women; they work as far as Pembrey. The cockles are carried to market at Swansea and Llanelly. They are also pickled in jars and sold in the neighbourhood. At Ferryside there is also a fishery for cockles and mussels, chiefly worked by the women from the opposite village of Llansaint". Bulstrode (1911) gave the 1909-10 figure of people engaged in the cockle industry at 250 at Penclawdd and 150 at Ferryside and Llansaint (see also Appendix III).

In Table 2 are shown figures for cockle landings obtained by M.A.F.F. collectors of statistics. These have mostly been taken from the published data in "Sea Fisheries Statistical Tables", but in some cases additional information has been provided by the District Inspector of Fisheries. Before 1911, cockles were grouped with "other shellfish" and the statistics could not be separated. From 1911 to 1923, cockles and mussels were grouped together as "other shellfish — mollusca" under Llanelly and Ferryside. Little is known about the actual quantity of cockles included in the figure given for each year, but in 1912 for example it is known that of the total of 41 160 cwt recorded only 3 000 were mussels — in the 1930s the quantities of mussels were somewhat larger than this (Table 2). The figures published relate only to cockles recorded as despatched from the railway stations shown, and therefore do not include cockles sold locally or transported by road. Statistics for Penclawdd do not appear until 1924, because although the railway station was opened in 1867, the stationmaster did not supply figures until 1924. Cockles and mussels were still given as a combined figure until 1926, when for the first time they were recorded separately. The mussel despatches are shown in brackets in Table 2 for comparison with the combined totals of earlier years. During the war years 1939-45 and up to 1949, shellfish landings were not separated for different stations and the only published records of cockles landed were the national totals of weight and value. The figures shown in Table 2 for the years 1939-49 were obtained by courtesy of the Ministry's District Inspector of Fisheries (Wales). From 1950 onwards cockle landings have been published under the heading of "Burry Inlet" and again these were apportioned, with the help of the District Inspector, to Llanelly (with Burry Port), Ferryside, Laugharne, and Llanrhidian Sands (the latter included cockles despatched from Swansea, Gowerton, Penclawdd and Loughor stations).

Table 2. *Annual landings of cockles from Llanrhidian Sands compared with those from neighbouring fisheries and with total landings in England and Wales —values mostly from M.A.F.F. "Sea Fisheries Statistical Tables".*

Year	Llanrhidian Sands		Llanelly	Ferryside	Laugharne	Total Burry Inlet+ "the Three Rivers"	Total landings England and Wales		
	Weight (cwt)	Approximate value* (£)					Weight (cwt)	Value (£)	Value per cwt s. d.
Recorded as "Other shellfish—Mollusca"									
1911	NR		3 380	NR	NR	NR	} Average 1909–1913		
1912	NR		3 680	41 160	NR	NR			
1913	NR		4 260	46 120	NR	NR			
1914	NR		4 780	42 040	NR	NR	} 180 762	18 397	2 0
1919	NR		6 552	47 000	NR	NR	NR		
1920	NR		6 852	43 520	NR	NR	NR		
1921	NR		7 950	32 860	NR	NR	NR		
1922	NR		6 570	25 200	NR	NR	156 423	42 888	5 6
1923	NR		974	20 400	NR	NR	124 417	30 216	4 10
Recorded as "Other shellfish—Mollusca" (Llanrhidian Sands under "Penclawdd")									
1924	15 877	3 969	506	23 772	7 346	47 501	179 292	41 213	4 7
1925	20 952	5 235	679	27 631	10 595	59 857	300 721	48 692	3 3
Recorded as "Cockles" and "Mussels" for separate stations (mussels given in brackets)									
1926	20 476 (0)	4 137	453 (132)	22 442 (3 011)	9 126 (565)	52 497	268 875	44 363	3 4
1927	19 723 (0)	3 945	175 (159)	27 389 (3 558)	9 823 (384)	57 110	251 381	47 071	3 9
1928	18 205 (0)	3 641	45 (65)	24 493 (4 097)	10 634 (1 042)	53 377	245 338	51 978	4 3
1929	18 082 (0)	3 616	0	17 303 (4 528)	11 125 (1 387)	46 510	204 275	42 971	4 2
1930	16 303 (0)	3 261	0	23 610 (5 524)	7 737 (2 000)	47 650	186 912	38 499	4 1
1931	23 641 (1 020)	4 933	0	11 988 (4 037)	7 420 (2 380)	43 049	161 639	35 471	4 5
1932	27 150 (1 610)	5 752	0	20 460 (5 734)	9 333 (1 369)	56 943	177 452	35 529	4 0
1933	27 350 (1 461)	5 762	0	15 116 (5 607)	9 674 (847)	52 140	189 001	34 789	3 8
1934	27 400 (1 590)	5 818	0	16 304 (4 683)	9 486 (1 168)	53 190	194 585	35 338	3 8
1935	27 480 (1 650)	5 826	0	16 518 (4 423)	10 345 (1 450)	54 343	206 443	31 821	3 1
1936	27 505 (1 325)	5 766	0	13 521 (4 557)	10 077 (1 533)	51 103	222 675	36 285	3 3
1937	29 170 (1 245)	6 085	0	8 478 (995)	4 988 (1 937)	42 636	243 405	44 436	3 8
1938	28 065 (990)	5 811	0	5 710 (1 473)	1 320 (1 509)	35 095	216 752	31 611	2 11

Table 2—*continued*

Annual landings of cockles from Llanrhidian Sands compared with those from neighbouring fisheries and with total landings in England and Wales —values mostly from M.A.F.F. "Sea Fisheries Statistical Tables".

Recorded only as totals for England and Wales—additional information from the District Inspector of Fisheries, Wales									
1939	27 460 (NR)	NR	0	7 987	2 478	37 925	204 197	32 908	3 3
1940	23 720	NR	0	6 529	2 013	32 262	128 317	22 860	3 7
1941	16 960	NR	0	1 160	683	18 803	136 714	33 423	4 11
1942	15 410	NR	0	0	2 899	18 309	156 334	41 865	5 4
1943	17 405	NR	0	718	3 874	21 997	121 423	39 045	6 5
1944	17 475	NR	0	2 414	2 825	22 714	117 351	42 149	7 2
1945	18 490	NR	0	1 598	3 257	23 345	139 966	50 640	7 3
1946	ca. 40 000	NR	0	NR	NR	48 262	201 459	73 083	7 3
1947	37 612	NR	4 132	4	2 456	44 204	175 857	74 472	8 6
1948	33 892	NR	5 249	4 489	1 024	44 654	155 547	62 386	8 0
1949	22 693	7 460	4 127	4 387	734	31 941	152 816	59 425	7 10
1950	19 725	6 060	3 428	866	0	24 019 (612)	135 405	53 023	7 10
1951	18 084	5 440	1 189	72	0	19 345 (311)	163 893	65 732	8 0
1952	22 124	6 738	1 845	591	14	24 574 (174)	149 209	65 026	8 9
1953	33 731	10 624	3 846	3 115	0	40 692 (375)	159 863	63 822	8 0
1954	35 322	11 164	2 547	5 029	0	42 898 (510)	137 390	55 861	8 2
1955	30 262	13 547	2 300	5 109	0	37 671 (582)	151 682	71 888	9 6
1956	25 158	14 906	2 096	4 107	0	31 361 (422)	136 081	70 729	10 5
1957	25 505	14 340	80	4 307	0	29 892 (546)	133 834	71 441	10 8
1958	11 958 [33 444]	[20 735]	159	48	5	12 170 (188) [33 656]	108 996	60 947	11 2
1959	8 666 [24 830]	[12 940]	0	211	0	8 877 (97) [25 041]	119 120	64 931	10 11
1960	2 962 [23 782]	[14 864]	0	1	237	3 200 (1 040) [24 020]	157 636	86 193	10 11
1961	17 076	10 497	0	5 208	0	22 284 (236)	163 684	90 453	11 1
1962	21 560	13 475	10	1 269	0	22 829 (386)	187 115	102 926	11 0
1963	11 821	7 873	10 981	0	0	22 802 (928)	126 945	87 498	13 9
1964	18 363	13 773	3 359	2 080	0	23 802 (1 690)	106 313	91 497	17 3
1965	27 797	27 797	17 348	7 205	0	52 350 (2 049)	135 075	110 813	16 5

*—Value may include mussels.
NR—no record.
[ ]—estimated landings and values (see text).

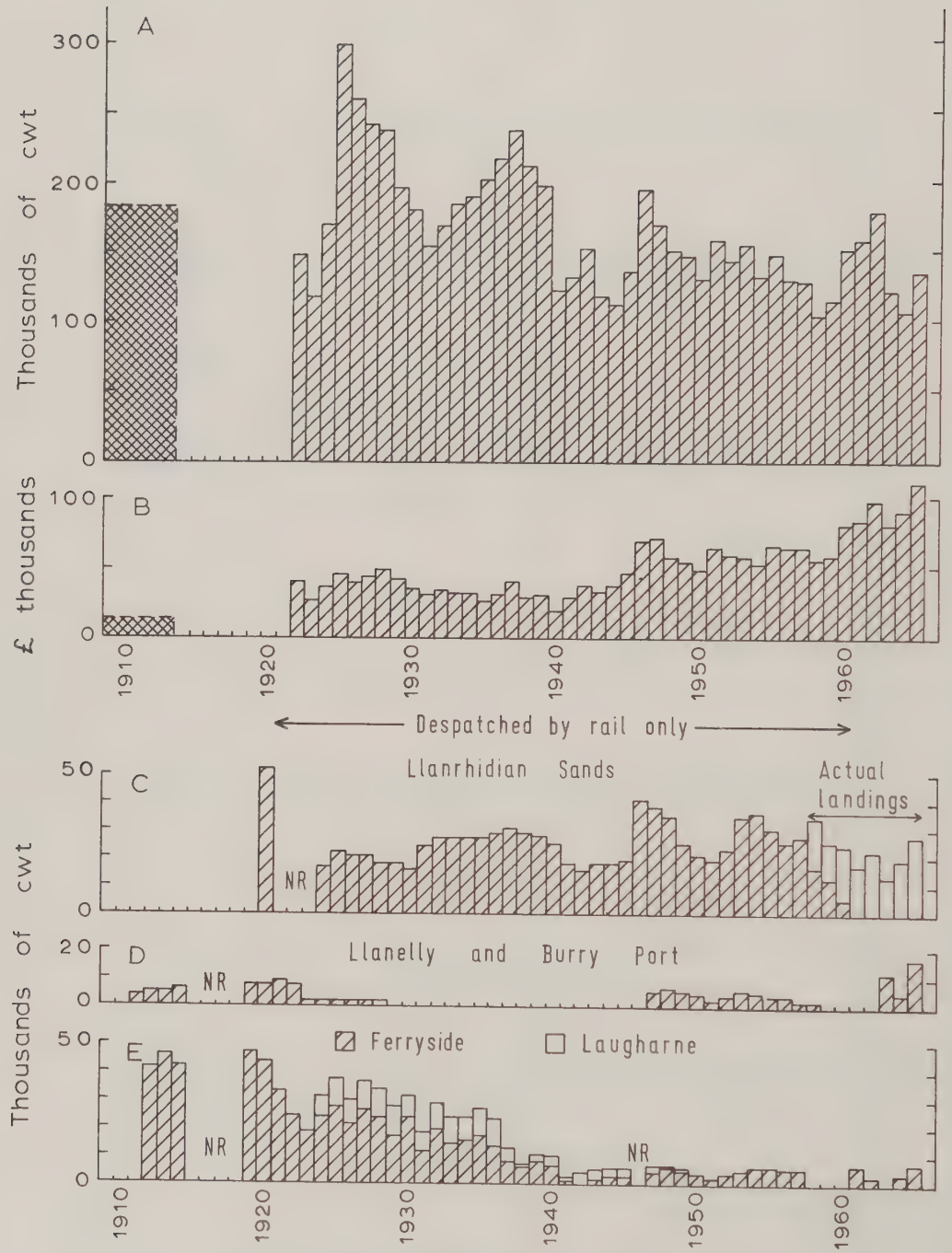


Fig. 7. *Records of annual landings of cockles, mainly from M.A.F.F. Sea Fisheries Statistical Tables, showing (A) the total weight for England and Wales, (B) the total value for England and Wales, (C) annual weights recorded from Llanrhidian Sands, (D) annual weights recorded from Llanelly and Burry Port, (E) annual weights recorded from Taf-Towy Inlet (Laugharne and Ferryside).*

The cross-hatched areas in A and B represent the national average for 1909-13.

N.R.=Not recorded.

In Figure 7, the landings of cockles for Llanrhidian Sands and Llanelly have been compared with the figures for landings from Ferryside and Laugharne, and with those for the whole country published annually in Sea Fisheries Statistical Tables. Some caution must be exercised when using these figures because, as will be seen from the Penclawdd records, the quantities despatched by rail may considerably underestimate the true landings. Nevertheless, bearing this in mind, it is still possible to notice general trends. Landings for the whole country show a series of peaks and troughs corresponding probably to preceding periods of good and poor settlement and survival. The marked peak in 1946 in both the national and the Llanrhidian Sands figures, in common with most other fisheries, is believed to represent the fishing of stocks accumulated during a period of under-exploitation during the war years. The M.A.F. report "Fisheries in Wartime" (1946) commented that landings of cockles and periwinkles showed a considerable decrease, no doubt because the gatherers found more profitable employment in wartime, but perhaps a more important cause was the widespread use of intertidal areas as military firing ranges. This was true of Llanrhidian Sands, where cockle gathering was severely restricted by practice firing and anti-invasion measures, and the numerous live cannon shells which continue to emerge from the sands to this day are among the daily hazards faced by cockle fishermen. In certain other areas in Great Britain, restrictions on cockle fishing in areas of military importance still exist, but in South Wales the only military restriction at present applies to road access to one cockle bed.

Before 1924, the only reference to quantities landed from Llanrhidian Sands is by Wright (1921a). This figure of 42 820 cwt was solely for cockles despatched by rail in 1920, and he was told that this represented only about two-thirds of the actual total. Wright claimed that in normal times the Penclawdd cockle industry employed 100-200 people in winter, rising to 200-250 in summer. These were exclusively women from Penclawdd and neighbouring villages, except during periods of local unemployment, such as due to stoppages in the coal industry, when a number of men took up cockle gathering. Gatherers were taking 2-3 cwt per tide. The only means of transport was by donkey, and the two hundred or so donkeys kept in Penclawdd are said to have been the source of considerable disturbance. From 1924 up to the beginning of the 1939 war, landings from Penclawdd showed only minor fluctuations. The decreased landings during the war were followed by the sudden rise in 1946 and then a gradual reduction until 1952. A sharp increase in 1953 followed an exceptionally good settlement of cockles in 1951, but thereafter the rail figures show an accelerating decline to the lowest recorded in 1960. It should be mentioned that, from 1953 until 1957 inclusive, large quantities of cockles were transported by road from Penclawdd to a bottling factory at Burry Port. These figures, which amounted to nearly 56 000 cwt in five years, were however included in the published statistics. When the present research programme was commenced in 1958, one of the most urgent tasks was to obtain more realistic figures for the actual landings of cockles. This was done by the South Wales Sea Fisheries Committee's Fishery Officer, Mr. K. J. Hutin, who made observations on the numbers of fishermen and their catches before they left the Llanrhidian Sands cockle beds. (Details of the method will be described in a later publication.) The estimates obtained in this way were found to be quite different. Published statistics for the Burry Inlet from 1960 onwards are based on direct observations on cockles landed and not on records from railway stations. The poor landings in 1963 resulted from heavy losses caused by the exceptionally severe winter of 1962-63 (Hancock and Urquhart 1964), but the unusually good settlement which followed in the summer of 1963 led to the improvement in landings shown for 1964.

Over 80, but more usually 40–50, cockle gatherers take part in the present fishery (1965) on Llanrhidian Sands and, as in Wright's (1921a) description, they are each taking 2-3 cwt per tide. The gatherers come from the nearby villages of Crofty, Penclawdd, Llanmorlais, Wernfrwdd, Penuel and even as far away as Gowerton and Loughor. Two important differences in the fishery since 1921 are firstly the almost complete replacement of donkeys by ponies and carts (Plate 7) — today only one or two donkeys remain (Plate 8) — and secondly the changeover from the large number of exclusively women gatherers (mostly concerned

with augmenting the family income) to a smaller group of regular gatherers including a good proportion (23%) of men completely dependent on the cockles for their livelihood. The use of ponies and carts on the one hand has permitted transport of larger individual catches, while the need for maintaining a livelihood lays emphasis on measures for regulating the fishery in order to maintain catches at an economic level.

In contrast to the Burry Inlet, the cockle fisheries of the Taf-Towy Inlet have suffered a persistent decline since the 1920s, when the total landings exceeded even those of the Burry Inlet, and have not reflected the periods of improved landings shown by the national picture or at Penclawdd (Figure 7). The three rivers area, however, like the Burry Inlet, received a very heavy cockle settlement during the summer of 1963 following the severe winter, and it will be interesting to see whether this leads to a rejuvenation of the fishery. At the present time (1965), there are only 14 regular gatherers, 11 women and 1 man from Llansaint, working the beds of Ferryside and the Gwendraeth, and 2 men from Laugharne fishing at Llanstephan (Figure 2).

On the north bank of the Burry Inlet (Llanelly and Burry Port), the spectacular increase in landings shown in Table 2 and Figure 7 for 1963 resulted from the great increase in effort when most of the gatherers from the south shore joined the 11 male local fishermen to take advantage of the much better survival of cockles which occurred there than on Llanrhidian Sands (Hancock and Urquhart 1964). This area also received a heavy spat-fall during 1963, and as already mentioned good catches were again being made by early 1965.

During local shortages of stocks, gatherers from the Burry Inlet may travel long distances to augment their supplies. In particular, the beds at Aberdovey in West Wales have often proved useful in this respect, as for example in the spring of 1959 when some 18 gatherers from Penclawdd took over 2 000 cwt.

FISHING METHODS

WRIGHT (1921a) described the Penclawdd cockle industry, and it appears that the methods used for collecting cockles have changed little during the past forty years. Cockle gathering in the Burry Inlet is entirely by hand, aided only by a "scrape", a curved metal blade with a handle covered with twine or cloth whipping, which is used for breaking the surface of the sand to allow easier movement of the short-handled rake by which the cockles are drawn together into piles (Plate 9 and Frontispiece). Some gatherers use a long-handled rake without first breaking the ground with a "scrape". The mixture of cockles, shells and sand is heaped by hand into a sieve, usually having a circular wooden frame about 18 inches in diameter and wired like an oblong-meshed builder's sieve — in fact, builders' sieves are frequently used. These are preferred to square-meshed sieves, because dead cockle shells which accumulate amongst the live cockles pass through the oblong meshes more easily. Efficient sieving of the wet sand from the cockles involves hard work and long practice (Plate 10). The smaller cockles which pass through the meshes are spread out over the surface of the sand. The distance between the cross wires of the sieves is related to legal regulations governing the minimum size of cockle which may be landed (Hancock 1963). The local by-laws (Appendix I) refer to a square-meshed sieve, but the onus is on the gatherer to provide an oblong-meshed sieve which will achieve retention of the same size of cockles. The catch of cockles is accumulated in galvanised buckets for final washing (Plate 11), usually in one of the streams flowing across the beds, and then transferred to sacks containing generally 3 buckets to a 1-cwt sack.

The only departure from this method has been the limited use of specially constructed hand dredges (Plate 6). The dredge is dragged towards the operator who moves backwards, pulling with sharp movements alternately one side of the handle then the other, whilst keeping the toothed blade below the surface of the sand. When used in a flowing stream, where cockles often accumulate, the sand is washed away through the diamond mesh, leaving clean cockles in the dredge. On surfaces with only a limited film of

water the dredge is up-ended and rocked vigorously from side to side, when cockles are again freed from the sand. The designer and one or two other gatherers claimed great success for this method during the late 1950s, particularly on beds containing larger cockles. For various reasons the use of dredges was discontinued for several years, though at the time of writing it is understood that dredging for cockles has been recommenced on the north shore of the Burry Inlet. Complaints that this method of dredging was causing much damage to young cockles were investigated, but it was concluded that when used on cockle beds after the tide had receded the damage caused by the dredge was less than by the conventional method of "scrape and rake".

Mondays to Thursdays, particularly Thursdays, are the most important days for gathering cockles on Llanrhidian Sands. On Fridays the amount gathered is reduced to about a quarter of the previous daily quantities, because many of the gatherers are preparing for or taking part in weekend markets. On Saturdays no cockles are gathered, as part of a conservation measure insituted by voluntary agreement amongst the gatherers. Sunday gathering is prohibited by a local Sea Fisheries Committee by-law (Appendix I).

As described by Wright (1921a) two grades of cockle are gathered. "Boiling" cockles are smaller ones cooked locally before being taken to market, while "shell" cockles are larger sizes obtained by more intensive sieving, by using larger-meshed sieves on the beds, or by concentrating on areas where larger cockles are known to occur. The clean, white shells of cockles from the more sandy areas of the beds are particularly sought after for this trade. These are either sold alive locally, or sent to more distant markets. The local Fishery Officer estimates that about 30% of the cockles gathered from the Llanrhidian Sands are sold in the shell. By contrast some 75% of landings from the north shore are despatched uncooked in the shell.

PREPARATION FOR SALE

A General account of the methods used for processing cockles has been given in a leaflet by Waterman (1963). At Penclawdd some of the cooking plants are run privately while others are organised on a communal basis. The communal plants, at each of which some 20-30 gatherers may pay to cook their cockles, are owned and run by cockle gatherers who are also retailers and distributors.

There are no Public Health Restrictions governing the gathering of cockles from the main commercial beds in the Burry Inlet, and the only small area with regulations covering the conditions of sale of gathered cockles is in Llanelly dock entrance (Appendix II). The attitude of Bulstrode in 1911 was to attach most importance to the conditions under which the cockles were boiled and washed, and he was concerned by the fact that cockles, which were in those days boiled over extemporised fireplaces along the foreshore (Appendix III), were frequently washed, after cooking, in streams which could have been polluted. By 1921, however, Wright (1921a) reported a great improvement, all water then used being drawn from the mains. Nowadays, cooking plants are housed in permanent buildings with fresh running water (Plate 12), and must conform to modern standards of food hygiene set by the Public Health Authority.

In a typical boiling plant at Penclawdd, cockles are transferred from sacks into circular wire baskets or perforated buckets which are placed two at a time in a small steamer, sealed except for a vent at the top and a drain at the bottom. A fast flow of steam enters the steamer for 6 minutes and during the cooking process shell liquor, released when the shells open, runs away through the drain. Each steamer holds about a bushel and usually two or three are worked in rotation (Plate 13). After cooking, the cockles are transferred through a hopper into a revolving cylindrical screen of chicken wire (Plate 14). The screen is powered electrically or by petrol engine, and the meats fall through the meshes into trays, while the shells drop out of the lower end of the screen into a chute leading to the outside. The shells are later ground into smaller fragments and sold for poultry grit which may add up to one-third of the value of the whole cockles.

The meats are washed in a series of containers of fresh water to cool them and to remove any grit or shell fragments. The women swirl the meats around with their arms (Plate 15), and they say that in May of each year, when there is always a sudden improvement in the meat yield of cockles, this is accompanied by unusual irritation of the skin. From May onwards, when shell growth also commences, the meat yield is good throughout the summer months, but then it declines gradually until the following April, when the amount of meat obtained will be only about two-thirds of the summer yield. The cockle meats are finally rinsed and packed into baskets (Plate 16). Salt may be mixed with the meats, particularly when they are to be kept for some time; in that case the salt is rinsed off before sale. The processing method differs from that employed in the Thames Estuary, where cooked cockles are stored and transported in brine (Waterman, 1963), and therefore need re-soaking in fresh water before sale, to reduce the salt content. During the summer, cockles are cooked regularly throughout the week to avoid spoilage, but in the colder months when cockles keep better the main cooking is done on Thursday and Friday, in preparation for the weekend markets.

MARKETING AND VALUE

Cockles form a popular item of the diet in South Wales and in times of local shortage supplies may need to be augmented from merchants in the Wash, the Thames Estuary or sometimes even Holland.

On Fridays and Saturdays, women gatherers sell their own cockles, cooked or in the shell, at Swansea market; others deliver cockles to houses throughout South Wales, often combining the delivery with a vegetable round. At midweek, deliveries are usually of whole uncooked or "shell" cockles, with mainly cooked meats at the weekend. From 1946 onwards up to 40 000 cwt of cockles were despatched from the various local railway stations (Table 2 and Figure 7), but by the late 1950s, when figures for total landings became available, this quantity had dwindled to less than 10 000 cwt, despite the fact that large quantities were still being gathered locally (Figure 7). It is not certain whether the proportion of cockles landed which are sent away by rail has changed, but certainly the closure in 1931 of the railway serving Penclawdd and also the increasing use of road transport locally will have had some effect. It has been mentioned that in the middle 1950s large quantities were taken (uncooked) by road to the bottling factory at Burry Port, where they were bottled in vinegar. Some cockles from Penclawdd still go to Burry Port, but the majority of those despatched by road or rail go to Cardiff, Bristol, Weston-Super-Mare, etc.

Table 2 shows, in addition to the quantities landed, their value, using figures given in Sea Fisheries Statistical Tables. It can be seen from Figure 7 that, although the total quantities landed in England and Wales have been falling gradually, their value slowly increased to a maximum of over £100 000 in 1962. Since 1961, on records of value at first sale alone, the cockle fishery has become the most valuable of the molluscan shell-fisheries. These records do not include the very large quantities of cockles imported from abroad, mainly from Holland, which in the late 1950s, at least, were considered to be nearly equal to those produced in this country. The average value of landings for England and Wales, apart from minor fluctuations, increased from 3-4s. per cwt in the 1920s to 11s. in the early 1960s. These must be regarded as rather conservative figures, even for the values of whole uncooked cockles at first sale. The increase to 13s. 9d. in 1963 reflected the national shortage of cockles following the severe winter of 1962-63, and later in that year as much as 25s. per cwt was being obtained in some places. Table 2 also shows how the total quantity landed fell by a third from 1962 to 1963, though the value was only slightly reduced.

The price obtained per cwt in South Wales appears, at least during the past ten years, to have been somewhat higher than the national average, and, according to the records, it has increased from about 9s. in 1955 to over 13s. in 1963, and up to £1 in 1965. The value of uncooked whole cockles however represents only a fraction of their value after cooking. Assuming a yield of from about $1\frac{1}{2}$ gallons of cooked flesh

per cwt in winter to just over 2 gallons in summer, when the yield is always better, cockles retailing at 2s. 6d. per pint on the South Wales markets, and even more when delivered to houses in the South Wales valleys, will be worth at least 30-40s. per cwt. To this must be added the value of the shells used for poultry grit, which will add about 5s. per cwt of whole cockles.

HISTORY OF LEGISLATION

In 1921, there was a by-law (Wright, 1921a) regulating the size of cockle which could legally be removed from Llanrhidian Sands. The legal minimum size was $\frac{3}{4}$ inch, i.e. no cockle should have been taken which would pass through an aperture $\frac{3}{4}$ inch square, but since 1914 this by-law had covered only "shell" cockles, i.e. despatched in the shell, and had been relaxed to allow the taking of boiling cockles down to $\frac{5}{8}$ inch. This situation continued until 1953 when the South Wales Sea Fisheries Committee, tired of the confusion and administrative difficulties resulting from the two sizes, asked for scientific advice from the M.A.F. and as a result standardized the minimum size at $\frac{11}{16}$ inch. Later, in 1959, as a result of fresh scientific evidence, the minimum size was raised to $\frac{3}{4}$ inch.

Extracts from current by-laws of the South Wales Sea Fisheries Committee, first published in 1953, which relate to cockles are shown in Appendix I. These are still operative, but in 1963 it was decided that the whole frame-work of legislation in the Burry Inlet would be strengthened by a Regulating Order under the Sea Fish Industry Act of 1868. The Burry Inlet Cockle Fishery Order became effective on 16 June 1965, and licenses for gathering were introduced on 1 January 1966.

By-laws (15-17) first published in 1957 were drawn up by the South Wales Sea Fisheries Committee to meet the special needs of the middle 1950s. With the use of lorries on the Llanrhidian Sands, cockles were being gathered indiscriminately during the summer months, to the detriment both of the winter fishery and of that of the following early summer. By-law 15 was introduced in an effort to reduce the "free-for-all" activities of the summer, and to stabilize the yield of the fishery throughout the year. It was hoped that by-laws 16 and 17 would have a similar effect as well as improving the chance of adequate supervision of the cockle fishery.

SCIENTIFIC OBSERVATIONS

The preceding description has been given in order to provide a background for the scientific observations, some of which have already been published (Hancock and Urquhart 1965) and others which will be published later. These include the results of surveys to estimate the stocks of cockles between 1958 and 1965, methods used to determine the losses from fishing and from natural causes, growth rates, seasonal changes in meat yield, etc. etc., all comprising the information needed for an assessment leading to the rational exploitation of cockles from Llanrhidian Sands.

ACKNOWLEDGEMENTS

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in Figure 6; to the Editor of "*The Guardian*" for permission to use Plate 11 and the Frontispiece; to Mr. B. Plummer for permission to use figures from his M.Sc. Thesis in Figure 3; to Mr. J. Howells for allowing us to examine samples of cockles at the boiling shed; and to the community of cockle gatherers for their cheerful co-operation throughout this work. Summer students D. Tsernaglou, J. Caddy, R. Hudson, M. Bracegirdle, and B. Russel helped with some of the field and laboratory work.

SUMMARY

1. The topography of the Burry Inlet has been described in relation to its position on the South Wales coast, and with particular reference to any changes within the estuary which may have affected the cockle fishery of Llanrhidian Sands.

2. The main cockle beds were found to be confined to an area between mean tide level and mean high-water level of neap tides.

3. A study of the history of the cockle fishery showed that it has existed for more than 100 years, though the main emphasis has shifted from a fishery with well over 200 part-time women gatherers to one with less than 100 gatherers, including men depending on the fishery for their livelihood.

4. Recorded annual landings from Llanrhidian Sands showed a serious decline from the year 1954. The fall in landings was still apparent after more realistic records were started in 1958, compared with earlier figures which were based only on cockles despatched by rail.

5. The traditional method of fishing by rake and "scrape" is still used, with rarely a specially constructed hand dredge. Cockles are marketed throughout South Wales, either cooked in the shell or more usually as cooked flesh.

6. The history of legislation covering the gathering of cockles in South Wales has been described.

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APPENDIX I

EXTRACTS FROM SOUTH WALES SEA FISHERIES COMMITTEE BYE-LAWS

(The South Wales Sea Fisheries comprises the International Territorial Limits between Rhymney River, Cardiff and Cemmaes Head, Pembrokeshire; including all islands.)

7. *Shellfish—Minimum Sizes*

No person shall remove from a fishery:

(c) Any cockle that will pass through the gauge of a riddle or like instrument used for the purpose of riddling, sorting, or sifting cockles having an aperture of $\frac{3}{4}$ of an inch square.

10. *Shellfish—Re-deposit of*

Any person who takes any shellfish, the removal of which from a fishery is prohibited by any of the Bye-laws, or the possession or sale of which is prohibited by or in pursuance of any Act of Parliament, shall forthwith re-deposit the same as nearly as possible in the place from where they were taken or under the written authority of the Clerk on other suitable ground, and in re-depositing cockles, in accordance with this Bye-law shall spread them thinly and evenly over the beds.

11. *Cockles—Instruments*

No person shall fish for cockles except:

(a) by hand; or

(b) with a hand-rake or hand-spade; or

(c) with a dredge when the cockle bed is covered with water, such dredge to be of a design to be first approved by the Committee.

12. *Regulation of Shellfish Beds*

Where, in the opinion of the Committee, in any fishery, any bed, or part of a bed of shellfish is so severely depleted as to require temporary closure in order to ensure recovery, or any bed or part of a bed contains mainly immature or undersized shellfish which in the interests of the protection and development of the fishery ought not to be disturbed for the time being, or any bed of transplanted shellfish ought not to be fished until it has become established, and where the bed or part thereof has been clearly defined in notices displayed in the vicinity prohibiting the removal or disturbance of the shellfish, or where the display of notices is not possible, written notice has been given by one of the Committee's officers, no person shall, while the bed or part thereof is so defined, take away or otherwise disturb any shellfish therein without the consent of the Committee.

14. *Deposit of Refuse*

No person shall deposit or discharge any solid or liquid substance detrimental to sea fish or sea fishing except in such places and at such times and in such quantities, and subject to such conditions as may from time to time be prescribed by the Committee, in writing, under the hand of their Clerk.

15. No person shall cause or permit any mechanically propelled vehicle to stand on or pass over any cockle bed.

16. No person shall fish for cockles on Sunday.

17. No person shall fish for cockles between half an hour after sunset on any day and half an hour before sunrise on the following day.

(Signed) T. A. Gibson
Clerk and Chief Fishery Officer to the
South Wales Sea Fisheries Committee, Swansea

1st January 1965

APPENDIX II

BOROUGH OF LLANELLY
PUBLIC HEALTH (SHELL-FISH) REGULATIONS, 1934 & 1948

In pursuance of the powers conferred on them by the Public Health (Shell-Fish) Regulations, 1934 and 1948, the Llanelly Town Council HEREBY MAKE the following Order:

(1) In this Order "prescribed area" means the mud flats forming part of and adjacent to the Inner Channel leading to the North Dock and which area lies between the southern extremity of the Llanelly Harbour Breakwater and the entrance to the said North Dock:

(2) A person shall not sell or expose or distribute or offer for sale or have in his possession for the purpose of sale for human consumption any cockles taken from within the prescribed area, unless such cockles have been:

- (i) subjected to a satisfactory process of cleansing at an establishment which is for the time being approved by the Minister of Health for the purpose;
- (ii) relaid in pure water for such period and in such places as may from time to time be approved for the purpose by the said Council; or
- (iii) subjected to a process of sterilisation by steam under pressure for at least six minutes in an apparatus which is for the time being approved by the said Council;
- (iv) subjected to any other process of sterilisation which is for the time being approved by the said Council.

(3) This Order shall come into operation on the

Tenth day of JANUARY 1959

GIVEN under the Common Seal of the Mayor, Aldermen and Burgesses of the Borough of Llanelly this Fifth day of January One thousand nine hundred and fifty-nine in the presence of: L.S.

(Sgd.) T. GLANVILLE WILLIAMS
Mayor

(Sgd.) S. SAMUEL
Town Clerk

APPENDIX III

Extract from "Shellfisheries other than oysters in relation to disease" by H. T. Bulstrode, 1911, pp. 194–6

THE CARMARTHENSHIRE MUSSEL AND COCKLE BEDS

This district, which extends along the south and west coasts of Wales from Worms Head to Cemmaes Head, embraces within its limits important areas over parts of which cockles and mussels are collected.

There are several estuaries on the south coast of Carmarthenshire wherein extensive tracts of sand are exposed at low water. This is notably the case in Burry Inlet, which extends between the Gower Peninsula and the mainland, i.e., off Penclawdd, Llanelly, and Pembrey, as well as at the mouths of the Towy and Taf Rivers.

The chief centres from which the cocklers set out are Laugharne, on the west, at the mouth of the Taf, Llanstephan, Ferryside, Llansaint, and St. Ishmaels, at the mouth of the Towy, and from Llanelly, Penclawdd, and Llanmorlais, in Burry Inlet.

The industry is almost entirely pursued by females, the males working in the adjoining coal mines or in some branch of the tin-plate industry; but during periods of trade depression or of strikes, a considerable number of men may be seen assisting the women in their labours.

The cocklers start from their homes, on the ebbing tide, walking across the sand in bare feet and short skirts, and accompanied by the donkeys, which are used to bear back the bags of shellfish. The work is of a severe nature, and involves in winter prolonged exposure to cold.

The cockle gatherers scrape the sand with what is practically a bent knife, or with a rake, carried in the right hand, while with the left hand the larger cockles are transferred to a riddle.

When this riddle is full, the cockles are riddled to separate the large from the small, and the large ones, after washing in a neighbouring pool of water, are transferred to a sack, which when full, and the day's gathering completed, is placed upon the back of one of the donkeys and the homeward journey commences.

Sometimes the women carry the smaller bags on their heads, or it may be that boats are used for bringing and taking back both cockle gatherers and their spoil.

The general methods of dealing with the cockles at one or another parts of the district are as follows:

(a) The cockles are despatched alive in their shells in sacks.
(b) The cockles are separated from their shells and the soft parts alone despatched.
(c) The separated cockles are salted with a view to preservation.
(d) The separated cockles are pickled in vinegar.

A brief description of the preparatory process, as practised at Penclawdd, a Flemish colony on the north coast of the Gower Peninsula, will alone be given:

Along the foreshore hereabouts, there are to be seen numerous extemporised fireplaces, banked up with sand on three sides to protect them from wind and open in front. Upon these fires the cockles are placed, contained in a large iron or tin cauldron, a small quantity of water having been first poured into the saucepan to prevent scorching. As the cockles gape, owing to the passage of steam from below, the sea-water contained between their shells is liberated, and thus the cockles may be said to be literally boiled in their own liquor, this liquor being at the end of each boiling decanted almost entirely into another receptacle near, to be used subsequently for the process of washing the cockles, only a small quantity being retained in the cauldron for use as above explained.

The cockles are kept on the fire until the water is actually boiling, when they are emptied into another receptacle and a fresh batch of living cockles placed in the cauldron.

The boiled cockles are then riddled over a table, the soft parts passing through the sieve, the shells remaining behind.

From time to time the cockles are washed in their own liquor and at the end of the process they are taken in a basket either to a neighbouring stream, to a spring, on to the foreshore, or to a pump or tap.

This fresh-water washing process is a very thorough one, in so far as I have witnessed it, its object being to rid the cockles of the sand which they naturally contain, and which imparts a gritty sensation to the teeth of the consumers.

At the end of a day's work at Penclawdd, there may be seen numerous cockle-wives sitting by the side of a rivulet which traverses the sands, awaiting their turn to wash their boiled cockles.

The cockles, when ready for market, are wrapped in white cloths, placed in baskets or small wooden tubs and taken to the neighbouring market towns by the cockle-wives, who may be seen in the early morning on the railway platforms with basket or tub deftly poised upon their heads.

On Saturdays a special train leaves Penclawdd for Swansea about 7 a.m., which is known as the "cockle-train", the cockle-wives bringing the cockles into Swansea by this train and returning by it in the evening.

As regards places such as Cardiff, Newport, Bristol, etc., I am informed by Dr. Morgan, the medical officer of health of Swansea, that women of 17 years old and upwards leave Penclawdd about Easter and act as the local-selling agents in these towns, the prepared cockles being forwarded to them from Penclawdd, to which place the cockle-sellers return about September, bringing with them as their savings some £30 to £60. In addition to this, Penclawdd has for the last four summers been visited by a wholesale agent, who purchases large quantities of uncooked cockles, which are sent in casks to America.

At Laugharne and some other places, if the cockles are intended for keeping, they are, after having been finally washed as described above, placed with cold water in the cauldron and allowed to remain on the fire until they "simmer", a process which is said to harden them and improve their keeping properties. The cockles are then heavily salted, i.e., a bag of 28 lb is added to every 60 quarts of cockles. It is stated that thus prepared these cockles will "keep" for a fortnight.

DESTINATION OF THE COCKLES

The cockles, either alive or boiled, find their way eventually to towns such as Cardiff, Swansea, Newport, Neath, Merthyr, Aberdare, Tredegar, Haverfordwest, Manchester, Bristol, Birmingham, Bath, Gloucester, Cheltenham, Swindon, and many other places, and they are despatched by train from St. Clears, Ferryside, Burry Port, and Penclawdd Stations as well as being hawked over neighbouring parts of South Wales in carts, fresh supplies of cockles being sent to meet the carts at different stations.

NUMBER OF PERSONS ENGAGED IN THE INDUSTRY

Captain Thomas, the Fishery Officer of the Milford Haven Sea Fisheries District, informs me that the approximate number of persons engaged in the industry at the several places above referred to is as follows:

At Penclawdd and Llanmorlais, 250 persons are engaged at times either in cockle gathering or boiling on the Gower coast.

At Ferryside and Llansaint, about 150; at Laugharne, 50; at Llanstephan, 12; and at St. Ishmaels, about 50.

The cockles in a cooked condition are despatched at a rate of about 250 half-cwts. per week (12 cwts. of uncooked fish will make less than half-cwt. of cooked).

Some idea of the value of this industry may be gathered from the fact that the weekly sale of cockles brings to the cocklers about £300.

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